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Author: Grzegorz Racki, Pierre Bultynck

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GRZEGORZ RACKI & PIERRE BULTYNCK

Conodont biostratigraphy of the Middle to Upper Devonian boundary beds in the Kielce area of the Holy Cross Mts

ABSTRACT: Principal stages in development of the conodont faunas of the passage facies area between the Kielce stromatoporoid-coral platform and Łysogóry intrashelf basin (*sensu lato*) in the vicinity of Kielce, the Holy Cross Mts, Central Poland, were apparently controlled by facies changeovers stemming from stepwise drowning of the Kielce shoal area. Abrupt transitions from an impoverished polygnathid to polygnathid-ancyrodellid (frequently enriched in *Polygnathus? dengleri*) to that of diverse pelagic polygnathid-mesotaxid (or icriodontid) biofacies, were a response to pulsatory eustatic rises. A sequence of early *Ancyrodella* species, crucial for recognition of the Middle/Upper Devonian boundary, is established at Wietrznia and Czarnów sections; in particular, a phyletic succession in the Wietrznia-I profile permits subdividision of the Mesotaxis falsiovalis Zone into at least 3 *Ancyrodella* levels of global correlation potential. Need of quantitative study of the early ancyrodellid variability, and revision of the series boundary-point in the global stratotype are emphasized, as well as complex ecologic provenances of ancyrodellids.

INTRODUCTION

The precise identification of the Middle/Upper Devonian boundary in sections of the Holy Cross Mts and adjacent areas in Central Poland was regarded (*e.g.* SZULCZEWSKI 1971, 1982) as very difficult to resolve owing to the general absence of conodonts, and other guide fossils in the dominating bank-to-reef facies. In particular, the discovery of Late Givetian conodont-bearing deposits (substages after RACKI 1993) was a first step leading to the recognition of this series boundary, and this was initially provided by RACKI (1985) at Kostomłoty.

Obviously, the search for the boundary events should be concentrated in the transitional zone between the shallow-water Kielce stromatoporoid-coral platform (with sparse conodont record; RACKI 1993) and broadly-defined Łysogóry basin deposits (which, unfortunately, are poorly exposed), *viz.* in the western part of the Kielce-Łagów Synclinorium (Text-fig. 1). The most prospective are there both the calcareous Wietrznia Beds (SZULCZEWSKI 1971; *cf. also* BULTYNCK 1982b) and mostly the argillaceous Szydłówek Beds of the Kostomłoty facies zone (RACKI & *al.* 1985).

The present paper is devoted to biostratigraphic analysis of conodonts obtained at eight localities which permits accurate zonal assignments of the strata (Text-fig. 2). Of broad aspect is the discussion on the evolution and ecology of conodonts around the Givetian/Frasnian boundary, especially of the guide ancyrodellids, and their relationships with eustatic events.

The paper summarizes a stage of cooperation between co-authors that started in 1984. One of us (PB) is responsible for taxonomic aspect, and the other (GR) for geological setting and regional implications; the parts on biostratigraphy and biofacies were written jointly.

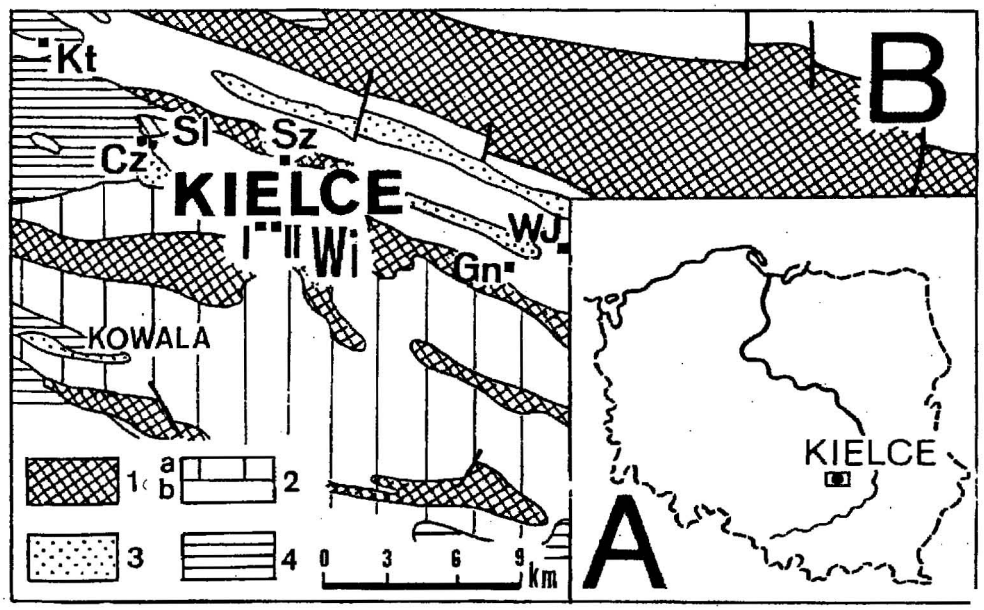
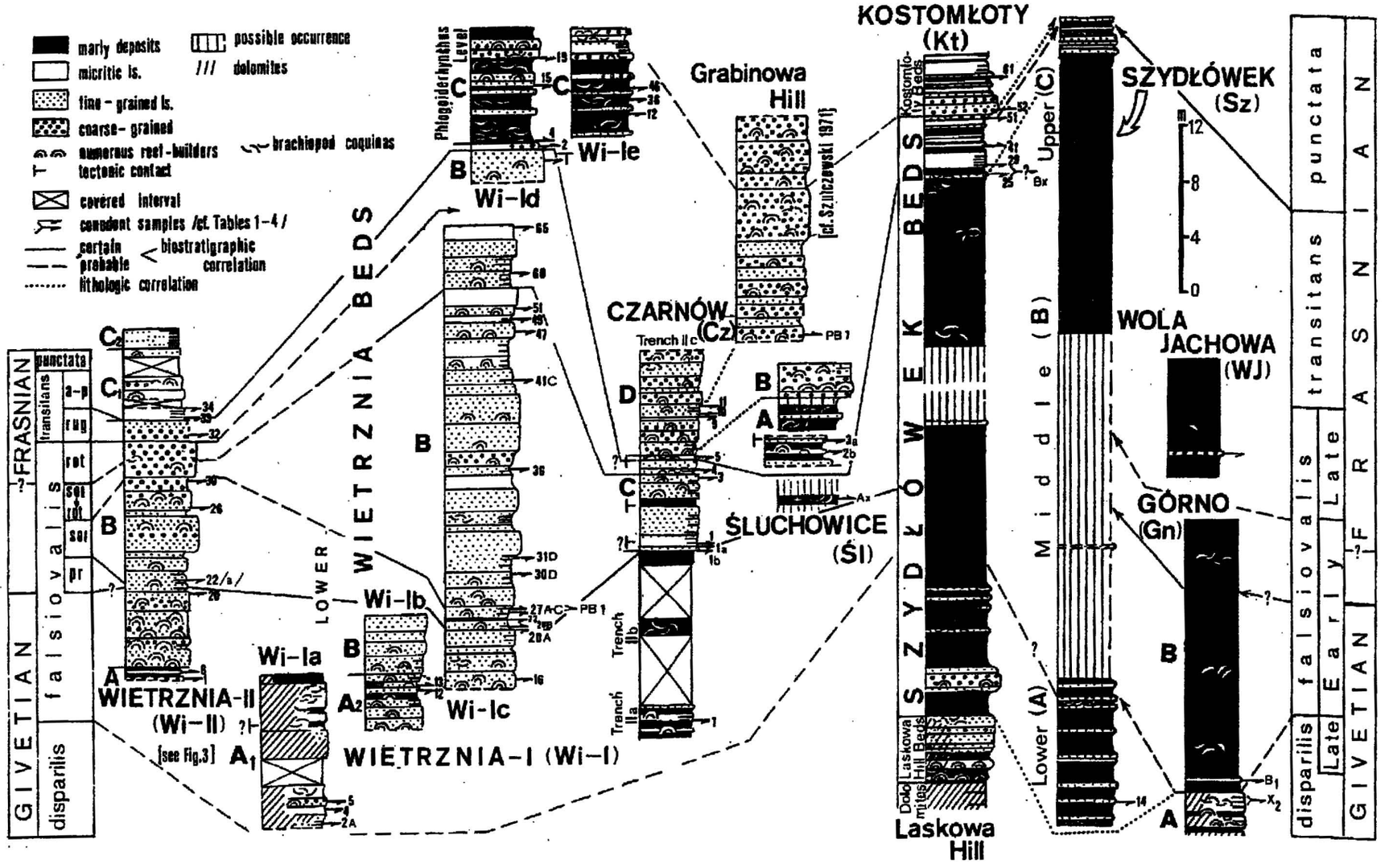


Fig. 1. Location of the studied exposures in Poland (A), and in the western part of the Holy Cross Mts (B; taken from RACKI & *al.* 1985, Fig. 1; *modified*)

STRATIGRAPHY: **1** — Lower Paleozoic, **2** — Devonian (**a** — Kielce facies, **b** — Kostomłoty-Łysogóry facies; paleogeographic pattern near the Givetian/Frasnian boundary), **3** — Lower Carboniferous, **4** — post-Variscan cover (Zechstein — Jurassic)

LOCALITIES: **Wi** — Wietrznia, **Cz** — Czarnów, **Sl** — Śluchowice, **Sz** — Szydłówek, **Kt** — Kostomłoty (western quarries), **Gn** — Górno (Józefka Hill), **WJ** — Wola Jachowa

Conodont-based correlation of the investigated sections in the Kielce-Łagów Synclinorium (*see* Text-fig. 1)



Sources of data: *Wi-Ic* adopted from MAKOWSKI (*in* RACKI & *al.* 1993, Fig. 10), Czarnów-Grabinowa Hill modified from SZULCZEWSKI (1971, Fig. 7), Laskowa mostly after RACKI & *al.* (1985, Fig. 2), Górno partly after MAŁKOWSKI (1981, Fig. 2)

ANCYRODELLA levels: **pr** — pristina, **sol** — soluta, **rot** — rotundiloba, **rug** — rugosa, **a-p** — africana-pramosica

Sample numbers usually follow the bed numbering except for pilot samples (*PB* — taken by P. BULTYNCK in 1985, others marked by *x*); only samples with determinable platform elements are included (for Śluchowice and Górno localities merely lower portions of the sequence are presented)

GEOLOGICAL SETTING AND LOCALITIES

The general stratigraphic context of the sections studied is presented by RACKI (1993; for details of litho-stratigraphic subdivisions see "*Register of*

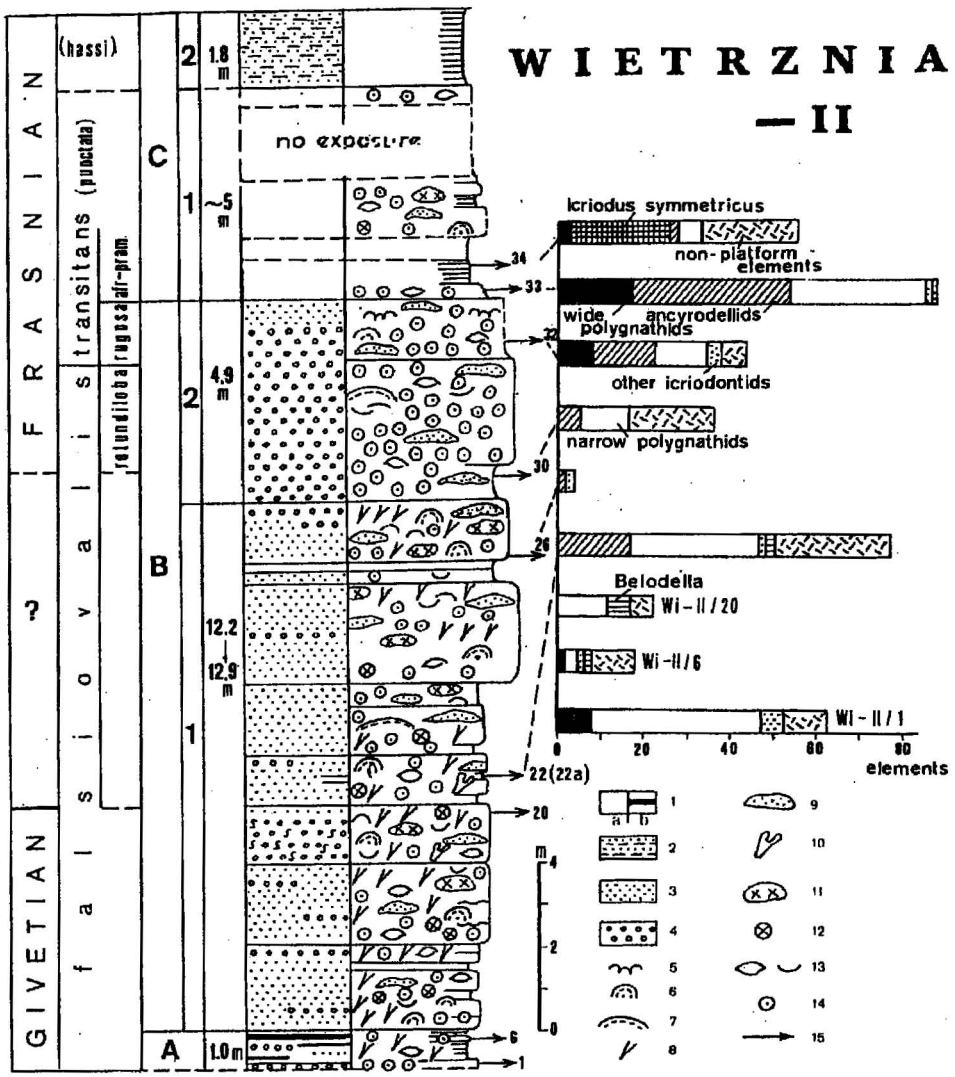


Fig. 3. Lithologic succession of the Wietrznia-II quarry showing the sequence of conodont faunas subdivided into eco-morphologic groups (*see* Text-fig. 7)

A-C — lithologic sets (*see* Text-fig. 2 and Pl. 1, Fig. 1); The placement of the Pa. punctata and Pa. hassi Zones is interpreted *from* SZULCZEWSKI (1971)

1 — calcilutites (a) and calcilutites with shaly intercalations (b), 2 — calcilutite-calcarenite rhythmic sequence, 3 — calcarenites, 4 — calcirudites, 5 — renalcid algae, 6 — subspherical stromatoporoids, 7 — tabular stromatoporoids, 8 — dendroidal stromatoporoids, 9 — massive tabulates, 10 — branched tabulates, 11 — massive rugosans, 12 — other rugosans, 13 — brachiopods, 14 — crinoid debris, 15 — conodont samples

localities" therein). A special emphasis is paid herein on two most significant sites: Wietrznia and Czarnów-Śluchowice.

WIETRZNIA

Widespread outcrops are present on the Wietrznia Hill, located in the eastern Kadzielnia Chain, in the southern part of Kielce.

Table 1

Distribution and frequency of conodonts in the Wietrznia-I section (*see* Text-fig. 2)

Stage	Givetian					Frasnian								
Conodont Zone	?falsiovalis					falsiovalis								
Characteristic level						?pr		sol		soluta+rotundiloba				
Section	Wietrznia-I (Wi-I)													
	a			b		c								
Sample number	2a	4	5	12	13b	16	A 20	B 20	22	A 27	B 27	C 27	PB 1	D 30
Sample amount	S	S	M	M	M	M	V	V	M	V	M	V	M	M
Total number of specimens	21	6	20	3	4	4	104	83	3	153	2	71	85	15
Ancyrodella	-	-	-	-	-	-	1	15	2	31	2	8	7	4
bindosa	-	-	-	-	-	-	-	1	-	-	-	-	-	-
pristina	-	-	-	-	-	-	1	4	-	4	-	-	-	-
pristina/soluta	-	-	-	-	-	-	-	-	-	-	-	2	-	2
soluta	-	-	-	-	-	-	-	6	2	23	2	6	7	2
soluta→rotundiloba	-	-	-	-	-	-	-	-	-	4	-	-	-	-
sp. indet.	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Polygnathus(?)	-	-	-	-	-	-	11	3	-	2	-	3	-	-
dengleri	-	-	-	-	-	-	11	3	-	2	-	3	-	-
Polygnathus	19	4	11	1	3	4	50	25	-	80	-	48	13	6
dubius	15	3	-	-	1	4	43	20	-	70	-	40	10	5
alatus	-	-	6	1	1	-	3	3	-	10	-	8	-	1
webbi	4	1	-	-	-	-	2	2	-	-	-	-	2	-
?*pollocki*	-	-	5	1	1	-	-	-	-	-	-	-	-	-
collieri	-	-	-	-	-	-	2	-	-	-	-	-	-	-
pennatus	-	-	-	-	-	-	-	-	-	-	-	-	1	-
sp. indet.	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Ozarkodina(?)	-	1	-	-	-	-	-	-	-	-	-	-	-	-
gradata	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Icriodus	-	-	8	-	-	-	1	4	1	10	-	5	5	1
latecarinatus	-	-	8	-	-	-	-	4	-	10	-	-	-	-
expansus	-	-	-	-	-	-	-	-	-	-	-	2	-	-
early *symmetricus*	-	-	-	-	-	-	-	-	-	-	-	1	-	-
sp. indet.	-	-	-	-	-	-	1	-	1	-	-	2	5	1
Belodella	-	-	-	2	-	-	8	5	-	-	-	4	-	-
bars & blades	2	1	1	1	1	-	33	30	-	30	-	3	60	4

Sample amount: S – small (< 1kg), M – medium (1-5 kg), L – large (5-10 kg) V – very large (> 10 kg)
Levels: pr – pristina, sol – soluta, rot – rotundiloba, rug – rugosa, afr-pram – africana-pramosica

Table 1 (*cnt'd*)

Stage	Frasnian															
Conodont Zone	falsiovalis								transitans							
Characteristic level							rot		rug	africana-pramosica						
Section	Wietrznia-I (Wi-I)															
	c								d					e		
Sample number	D 31	36	C 41	47	49	51	60	65	1	2	14	15	19	12	36	46
Sample amount	M	M	M	L	M	M	M	L	S	S	S	S	M	S	S	S
Total number of specimens	6	5	22	64	9	28	47	54	17	6	55	10	70	4	5	4
Ancyrodella	1	-	4	-	2	3	6	6	4	5	2	2	24	4	3	3
pristina	1?	-	4	-	1	2	-	-	-	-	-	-	-	-	-	-
soluta	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
rotundiloba	-	-	-	-	-	-	3	4	-	2	-	-	-	-	-	-
soluta→rugosa	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
?rotundiloba→africana	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
rugosa	-	-	-	-	-	-	-	-	2	2	1	1	20	1	-	2
alata	-	-	-	-	-	-	-	-	2	-	2	-	1	1	3	1
pramosica	-	-	-	-	-	-	-	-	-	1?	-	-	-	-	-	
arficana	-	-	-	-	-	-	-	-	-	-	-	-	1?	-	-	-
cf. *gigas*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
sp. indet.	-	-	-	-	-	1	1	-	-	-	2	1	-	1	-	-
Klapperina	-	-	-	-	-	-	-	-	3	10	1	-	-	-	-	-
ovalis	-	-	-	-	-	-	-	-	3	10	1	-	-	-	-	-
Mesotaxis	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
asymmetrica	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Polygnathus(?)	-	2	3	15	1	12	3	3	-	1	-	-	-	-	-	-
dengleri	-	2	3	15	1	12	3	2	-	1	-	-	-	-	-	-
cristatus	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Polygnathus	4	2	12	25	6	9	20	15	7	-	21	-	13	-	1	-
dubius	4	2	10	25	-	7	14	5	7	-	20	7	12	-	1	-
alatus	-	-	2	-	-	-	5	2	-	-	-	-	1	-	-	-
webbi	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
?pollocki	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-
pennatus	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-
angustidiscus	-	-	-	-	-	2	1	-	-	-	1	-	-	-	-	-
Ozarkodina(?)	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-
sannemanni	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
proxima	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Icriodus	-	-	-	-	-	2	-	-	3	1	-	-	30	-	1	1
early *symmetricus*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
symmetricus	-	-	-	-	-	-	-	-	3	1	-	-	30	-	1	1
bars & blades	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-

In a series of inactive quarries at Wietrznia there are stratified, fossil-rich limestones considered already by GÜRICH (1896) as transitional strata between the Middle and the Upper Devonian ("*Uebergangschichten von Wietrznia*"). Subsequently, however, CZARNOCKI (1948) included the entire sequence into the Frasnian, and this timing has been commonly accepted until now, despite the ambiguous age of its oldest portion (SZULCZEWSKI 1971), and recent definition of this series boundary (*cf.* BULTYNCK 1982b, Fig. 4).

The present study confirms that the Wietrznia Beds straddle the Middle/Upper Devonian boundary. It is based on more detailed measuring (MAKOWSKI *in* RACKI & *al.* 1993) and sampling of the most south-western and eastern parts of the exposure (Pl. 1), designated after SZULCZEWSKI (1971) as Wietrznia-I (*Wi-I*) and Wietrznia-II (*Wi-II*), respectively.

There is an overall lithological uniformity within the lower Wietrznia Beds, within the both sections mentioned above, which are separated by about 800 m. Consequently, the terminology of major lithological sets, introduced by SZULCZEWSKI (1971), is adopted here albeit in a modified form.

The following three lithologic units (*see also* MAKOWSKI *in* RACKI & *al.* 1993) were sampled for conodonts (Text-figs 2-3):

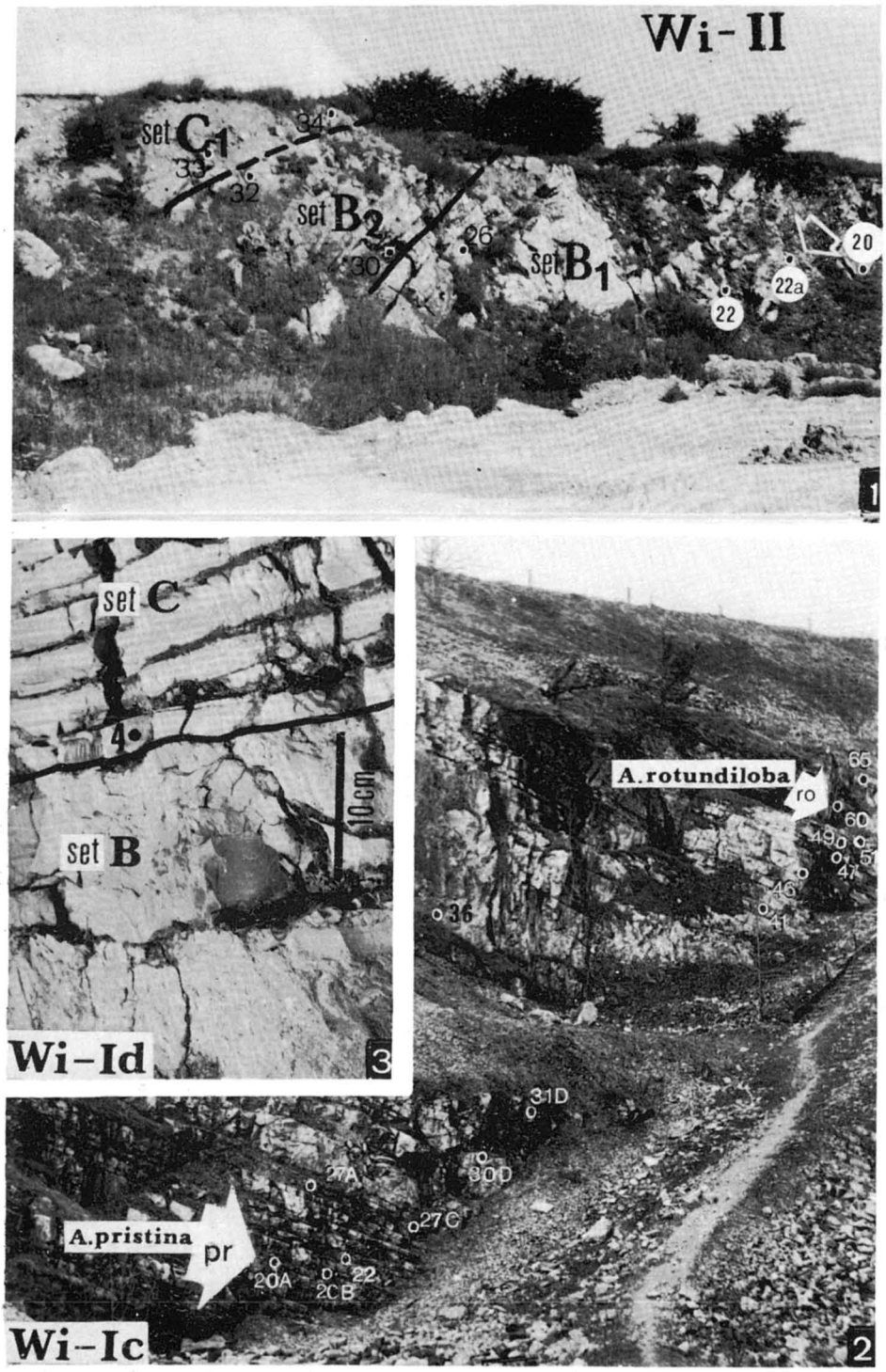
A. Thin-bedded, mostly dark and fine-grained limestones, with marly and/or knobby interbeds, up to 1 m thick, containing rich and varied, frequently redeposited coral and stromatoporoid skeletons, brachiopods (atrypid-gypidulid fauna), receptaculitids and crinoid debris. The presence of *Amphipora*-bearing argillaceous intercalations, and small alveolitid bindstone buildups, are noteworthy. In addition, thick layers of mainly poorly fossiliferous micrites, that are capped with brachiopod-rich marly black strata, occur locally as a tectonic wedge near a dolomitized stock (subsection *Wi-Ia*) in the southern wall of the Wietrznia-I quarry. Therefore, set A, which is now mostly covered, is subdivided in this outcrop into two minor units, A_1 and A_2 (Text-fig. 2).

B. Typically thick-bedded and light biorudites containing fossils similar to that in the set A (*see* Text-fig. 3 for distinct succession of faunal assemblages at Wietrznia-II). The separation of the units is arbitrary, and the re-defined set B comprises the entire SW wall at the Wietrznia-I exposure (*Wi-Ic*; Pl. 1, Fig. 2). There is gradation into more massive strata in the eastern wall of this quarry, and Kadzielnia-type stromatoporoid/coral bioherms (*cf.* SZULCZEWSKI & RACKI 1981) are possibly linked with this unit.

C. Thin-bedded (of platy or wavy aspect) brachiopod-rich micrites with detrital and/or shaly intercalations (*Phlogoiderhynchus* Marly Level of RACKI 1993). The strata are more argillaceous and bituminous along the northern wall of Wietrznia-I (*Wi-Id* and *Wi-Ie*; Pl. 1, Fig. 3), and marked by laterally variable coarse-grained layers, with many broken reef-builders and flat micritic clasts. Their correlatives at Wietrznia-II, now only partly accessible, are thought herein to be at least bipartite (Text-fig. 3): (C_1) mostly platy micrites with shelly and/or crinoid partings, followed by (C_2) gray unfossiliferous, rhythmically stratified micrites and pelbiosparites (*see* SZULCZEWSKI 1971, p. 95).

The overlying strata are coarsely bedded, predominated by varied detrital (*Wi-I*) or micritic (*Wi-II*) lithologies of the upper Wietrznia Beds.

Above 50 samples, weighing up to 10 kg, were taken from the two sections, and most of them yielded platform conodonts biostratigraphically useful for dating the Givetian/Frasnian passage beds (Tables 1-2). A total of almost 1000 elements from Wietrznia-I (35 samples), and 400 at



Wietrznia quarries at Kielce (*see* Text-figs 1-3)

1 — Eastern fragment of the Wietrznia-II locality showing location of samples (numbered as in Table 2)
2-3 — Wietrznia-I quarry: **2** — South-western part (profile *Wi-Ic*) to show sequence of the lower Wietrznia Beds (set B); entry levels of *Ancyrodella pristina* (= Givetian/Frasnian boundary in the present sense) and *A. rotundiloba* are arrowed; **3** — Fragment of the northern wall (section *Wi-Id*) showing contact between the lower Wietrznia Beds (set B) and the *Phlogoiderhynchus* Level (set C); numbers refer to samples (Table 1)

Wietrznia-II (15 samples) have been collected. The interval from the basal Mesotaxis falsiovalis to Palmatolepis transitans Zones is, therefore, fairly well documented in the sections; the former zone comprises the bulk of sets A and B.

Table 2

Distribution and frequency of conodonts in the Wietrznia-II section (*see* Text-figs 2-3)

Stage	Givetian			Frasnian						
Conodont Zone	falsiovalis							transitans		
Characteristic level				soluta				rug	afr-pram	
Section	Wietrznia-II (Wi-II)									
Sample number	1	6	20	22	22a	26	30	32	33	34
Sample amount	M	M	M	L	L	M	L	L	M	M
Total number of specimens	62	18	23	49	28	3	37	44	91	55
Ancyrodella	-	-	-	7	10	1	5	15	36	1
binodosa	-	-	-	1	-	-	-	-	-	-
pristina	-	-	-	3	4	-	1	1	-	-
soluta	-	-	-	3	5	1	4	1	-	-
rotundiloba	-	-	-	-	-	-	-	1	6	1?
rugosa	-	-	-	-	-	-	-	3	3	-
alata	-	-	-	-	-	-	-	2	5	-
pramosica	-	-	-	-	-	-	-	-	2	-
africana	-	-	-	-	-	-	-	-	1	-
sp. indet.	-	-	-	-	-	-	-	7	19	-
Mesotaxis	2	-	-	-	-	-	-	1	-	2
falsiovalis	2	-	-	-	-	-	-	1	-	-
asymmetrica	-	-	-	-	-	-	-	-	-	2
Skeletognathus	5	1	-	-	-	-	-	-	-	-
norrisi	5	1	-	-	-	-	-	-	-	-
Klapperina	-	-	-	-	-	-	-	5	13	-
ovalis	-	-	-	-	-	-	-	5	12	-
unilabius	-	-	-	-	-	-	-	-	1	-
Polygnathus(?)	-	-	-	-	-	-	-	2	5	-
dengleri	-	-	-	-	-	-	-	2	5	-
Polygnathus	40	3	12	19	10	-	12	12	35	6
dubius	18	1	10	18	5	-	12	12	35	6
alatus	12	-	2	1	5	-	-	-	-	-
webbi	10	2	-	-	-	-	-	-	-	-
Icriodus	4	2	-	1	1	2	-	3	1	24
latecarinatus	4	-	-	-	-	2	-	1	-	-
subterminus	-	1	-	-	-	-	-	-	-	-
expansus	-	-	-	-	-	-	-	2	1	-
symmetricus	-	-	-	-	-	-	-	-	-	24
sp. indet.	-	1	-	1	1	-	-	-	-	-
Belodella	-	2	5	2	-	-	-	-	1	-
bars & blades	11	10	6	20	7	-	20	6	-	22

CZARNÓW-ŚLUCHOWICE

The oldest beds in the well-known Śluchowice quarry located in NW part of Kielce, were described by CZARNOCKI (1948) and SZULCZEWSKI (1971) as the Lower Frasnian shales and marls with *Leiorhynchus* (=*Phlogoiderhynchus*) *polonicus* (ROEMER, 1866), assignable to the Szydłówek Beds (*see also* BIERNAT & SZULCZEWSKI 1975, SZULCZEWSKI 1982). They are succeded by a coarse-grained and fossiliferous sequence, well exposed in old pits along the Grabinowa Hill, 300 m further to W, beside of the Kielce-Czarnów railway station, and dated by SZULCZEWSKI (1971) as undivided Lower and Middle Polygnathus asymmetricus Zones.

The oldest portions of the sequence at Czarnów, with the Givetian to Frasnian passage beds, were observed at trenches *Cz-II* (Text-figs 2 and 4, and Pl. 2, Fig. 1) on the NE slope of the Grabinowa Hill (*see also* FILONOWICZ 1967). Above the partly dolomitized Early(?)-Middle Givetian micrites with biostromal, and brachiopod and gastropod coquinas intercalations (*Stringocephalus* Beds; set A) at least three complexes are recognizable even though the outcrops are fragmentary and severely tectonically disturbed.

Black marly rhythmic succession (set B), comprising alternating limestones and shales with *Ph. polonicus* and *Styliolina* (see HAJŁASZ 1993 for description) are probably strongly reduced tectonically (13 m in thickness); the unit ultimately includes, however, nodular coral- and stromatoporoid-rich beds in the exposed basal part, assignable possibly to the topmost Laskowa Hill Beds. Typical Szydłówek Beds occur also in the railroad escarpment, S of the Śluchowice quarry (see sample *Sl/Ax* in Text-fig. 2).

The transitional complex C is typified by both sparsely fossiliferous fine-grained deposits, and subordinate intercalations of the Szydłówek-type; the above-mentioned oldest marly strata from Śluchowice (set A), are referred to this unit which is at least 7 m thick. The overlying intraformational conglomerates with calcarenite interbeds and abundant reef-builder rubble were described already by SZULCZEWSKI (1971, pp. 60-61). Both detrital sets (C-D) are placed in the lower Wietrznia Beds, although lithostratigraphic context of the older strata is somewhat ambiguous (*see also* RACKI 1993).

As elsewhere, stratigraphically useful conodonts were not found in the argillaceous Szydłówek Beds (*cf.* SZULCZEWSKI 1982, RACKI 1985). Numerous and varied ancyrodellids occur in the Wietrznia Beds at both localities: 14 productive samples contain about 300 specimens indicative of the M. falsiovalis and Pa. transitans Zones (Table 3).

SZYDŁÓWEK

A succession of more than 50 m thick, marly and black suite of the Szydłówek Beds is fragmented, and crops out periodically along the Szydłówek Hill in northern Kielce (BIERNAT & SZULCZEWSKI 1975). Most data on this succession ("*Stinkalke von Szydlówek*" of GÜRICH 1896) came from several temporary ditches, and road escarpment along Manifest Lipcowy Street (suburb of Bocianek).

Table 3

Distribution and frequency of conodonts in the Czarnów (*Cz*) and Śluchowice sections (*see* Text-figs 2 and 4)

Stage	Giv.	Frasnian										?	Frasnian	
Conodont Zone	?	falsiovalis					transitans					?	transitans	
Characteristic level		soluta			rot		afr-pram					?	afr-pram	
Section	Czarnów (Cz)											Śluchowice		
	IIa	IIc									Hill			
Sample number	7	1b	1a	1	3	4	5	9	10	11	PB-7	Ax	2b	3a
Sample amount	M	L	M	L	S	S	M	S	S	S	M	M	M	M
Total number of specimens	7	41	13	22	25	29	42	8	13	2	27	6	30	41
Ancyrodella	-	15	3	5	2	5	9	2	2	2	1	-	12	3
pristina	-	-	1	-	-	-	-	-	-	-	-	-	-	-
pristina/soluta	-	7	-	-	-	-	-	-	-	-	-	-	-	-
soluta	-	8	1	5	1	-	-	-	-	-	-	-	-	-
soluta→rotundiloba	-	-	-	-	-	2	-	-	-	-	-	-	1	1
rotundiloba	-	-	-	-	-	2	-	-	-	-	-	-	-	-
rugosa	-	-	-	-	-	-	4	1	2	2	1?	-	4	1
africana	-	-	-	-	-	-	2	-	-	-	-	-	4	-
sp. indet.	-	-	1	-	1	1	3	1	-	-	-	-	3	1
Klapperina	-	-	-	-	-	-	-	2	-	-	5	-	-	-
ovalis	-	-	-	-	-	-	-	2	-	-	5	-	-	-
Mesotaxis	-	-	-	-	1	-	-	-	5	-	-	-	2	13
asymmetricus	-	-	-	-	-	-	-	-	2	-	-	-	-	-
falsiovalis	-	-	-	-	-	-	-	-	-	-	-	-	2	13
sp. indet.	-	-	-	-	1	-	-	-	3	-	-	-	-	-
Polygnathus(?)	-	2	2	-	3	1	7	-	-	-	-	-	2	8
dengleri	-	2	2	-	3	1	2	-	-	-	-	-	2	8
dengleri→M. falsiovalis	-	-	-	-	-	-	4	-	-	-	-	-	-	-
ordinatus	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Polygnathus	4	24	8	13	9	20	21	1	2	-	6	4	13	16
dubius	3	24	7	11	5	15	5	1	2	-	-	3	5	16
alatus	1	-	-	-	4	5	5	-	-	-	-	1	3	-
webbi	-	-	-	1	-	-	2	-	-	-	-	-	-	-
pennatus	-	-	1	1	-	-	7	-	-	-	-	-	-	-
pollocki	-	-	-	-	-	-	1	-	-	-	6	-	5	-
caelatus	-	-	-	-	-	-	1?	-	-	-	-	-	-	-
Icriodus	-	-	-	-	-	-	-	-	1	-	-	-	-	-
sp. indet.	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Belodella	3	-	-	-	-	-	-	-	-	-	-	-	-	1
bars & blades	-	-	-	4	10	3	5	3	3	-	15	2	1	-

The lower and uppermost parts of that sequence comprise many fine-grained layers (up to 70 cm thick; Pl. 2, Fig. 2), representing mostly calcispheroid intrabiosparites. This pattern is known also from Kostomłoty (*cf.* RACKI & *al.* 1985) and is the basis of the three-fold framework of the Szydłówek Beds (sets A-C; Text-fig. 2). Apart from common styliolinids and rhynchonellids of the species *Phlogoiderhynchus polonicus*, the more diversified fossil assemblages with varied brachiopods, *Amphipora* sticks, crinoid remains (with *Haplocrinus* crowns; GŁUCHOWSKI 1993) and trilobites are found in the lower part of this unit, especially in some gray marly layers (*cf. also* BIERNAT & SZULCZEWSKI 1975, RACKI & *al.* 1985). A sliver of the fossil-impoverished upper fragment of the Szydłówek Beds, exhibiting monotonous shaly-marly aspect and with several mostly calcarenite platy layers at the top, is visible in the road cut (Text-fig. 4).

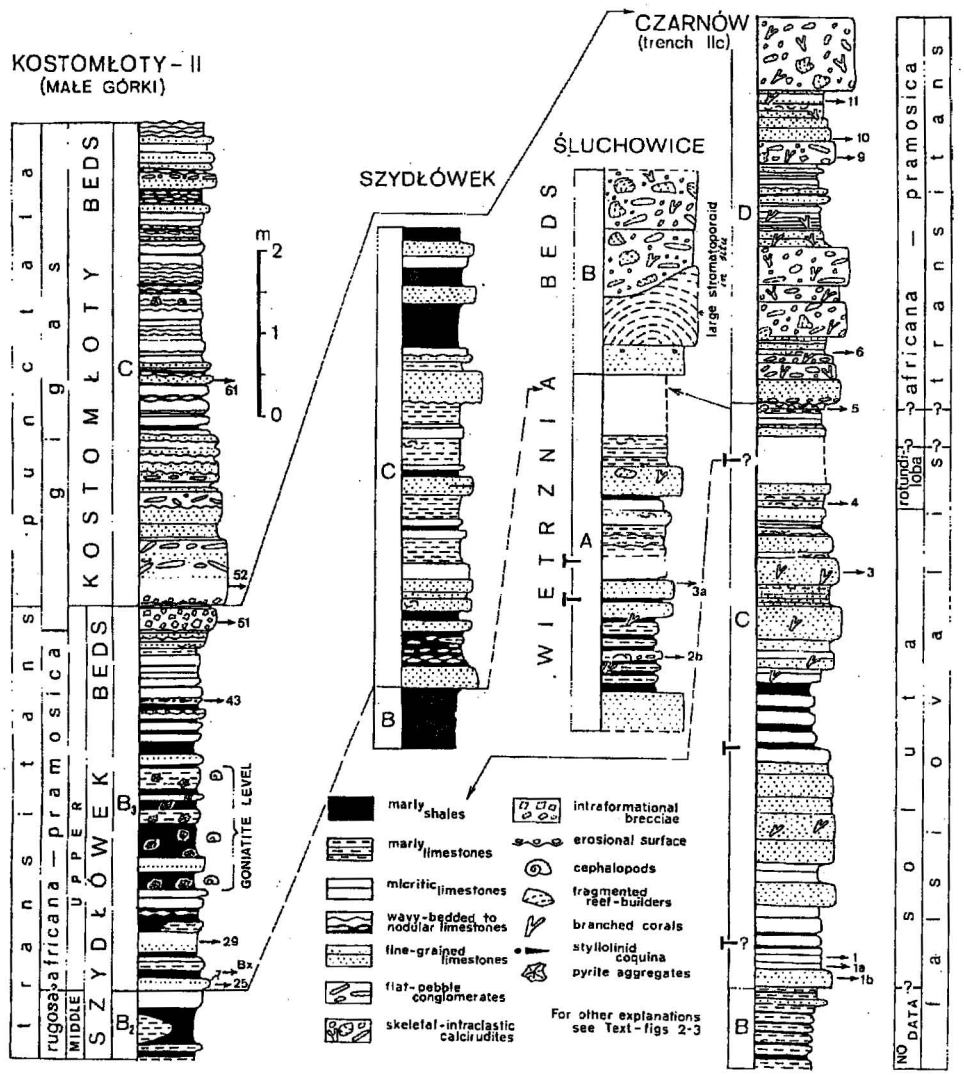


Fig. 4. Correlation of the Early to Middle Frasnian sections in the Kostomłoty facies zone based on conodonts

Table 4

Distribution and frequency of conodonts in the Szydłówek (*Sz*), Górno (*Gn*), Wola Jachowa (*WJ*) and Kostomłoty (*Kt*) sections (*see* Text-figs 2 and 4)

Stage	Givetian			Frasnian							
Conodont Zone	disparilis			falsiovalis	transitans				punctata		
Characteristic level				?rot	afr-pram				gigas		
Section	Sz	Gn		WJ	Kostomłoty-II (Kt)						
Sample number	14	A-X$_2$	B-1	1	Bx	25	29	41	51	52	61
Sample amount	L	M	M	M	M	M	M	M	M	M	M
Total number of specimens	88	26	48	25	75	71	31	41	44	14	50
Ancyrodella	-	-	-	3	25	22	-	11	2	1	2
soluta	-	-	-	1?	-	-	-	-	-	-	-
rotundiloba	-	-	-	-	-	1	-	2	-	-	-
rugosa	-	-	-	1?	6	2	-	2	-	-	-
alata	-	-	-	-	2	1?	-	-	-	-	-
pramosica	-	-	-	-	4	-	-	2	-	-	-
africana	-	-	-	-	5	2	-	-	-	-	-
aff. *gigas*	-	-	-	-	1	-	-	1	-	-	-
gigas	-	-	-	-	-	-	-	-	2	1	2
sp. indet.	-	-	-	1	7	16	-	4			
Schmidtognathus	1	-	-	-	1	-	-	-	-	-	-
peracutus	1	-	-	-	1?	-	-	-	-	-	-
Klapperina	16	-	-	-	9	1	4	5	14	2	-
disparillis	9	-	-	-	-	-	-	-	-	-	-
ovalis	-	-	-	-	9	-	1	-	-	-	-
unilabius	-	-	-	-	-	1	3	5	14	2	-
sp. indet.	7	-	-	-	-	-	-	-	-	-	-
Polygnathus(?)	7	-	-	-	2	2	1	-	-	-	-
dengleri	4	1?	-	-	2	2	1	-	-	-	-
cristatus	3	-	-	-	-	-	-	-	-	-	-
Skeletognathus	-	-	1	-	-	-	-	-	-	-	-
norrisi	-	-	1	-	-	-	-	-	-	-	-
Mesotaxis	-	-	-	-	15	2	10	3	3	-	
falsiovalis	-	-	-	-	-	1	-	-	1	-	-
asymmetrica	-	-	-	-	15	1	-	10	2	3	-
Palmatolepis	-	-	-	-	-	-	-	-	6	-	17
transitans	-	-	-	-	-	-	-	-	-	-	2
punctata	-	-	-	-	-	-	-	-	6	-	15
Polygnathus	29	15	23	10	15	17	17	10	7	3	12
caelatus	4	-	-	-	-	-	-	-	-	-	-
dubius	17	15	20	8	15	13	10	5	2	-	-
webbi	-	-	3	-	-	-	-	-	-	-	-
alatus	-	-	-	2	-	3	-	-	-	-	-
pennatus	-	-	-	-	-	1	1	-	-	-	-
?pollocki	-	-	-	-	-	-	6	5	-	-	-
aequalis	-	-	-	-	-	-	-	-	-	-	10?
sp. indet.	8	-	-	-	-	-	-	-	5	-	2
Ozarkodina(?)	-	-	-	-	-	1	-	-	-	-	-
aff. *proxima*	-	-	-	-	-	1	-	-	-	-	-
Icriodus	-	10	9	5	5	6	-	6	-	-	4
latecarinatus	-	6	9	-	-	-	-	-	-	-	-
aff. *brevis*	-	2	-	-	-	-	-	-	-	-	-
early *symmetricus*	-	-	-	5	-	-	-	-	-	-	
symmetricus	-	-	-	-	5	6	-	1	6	-	4
sp. indet.	-	2	-	-	-	-	-	-	-		
Belodella	-	-	3	-	-	-	-	-	-		
bars & blades	35	-	12	7	3	20	10	3	6	5	15

In spite of extensive sampling of various lithologies, merely one sample *Sz*-14 taken from a gray micrite interbed, proved to be sufficiently productive; the conodonts demonstrate the latest Givetian age for the lower part of the Szydłówek Beds (Table 4).

KOSTOMŁOTY

RACKI (1985), when studying the conodont succession in the Givetian to early Frasnian strata at two adjoining active quarries (Laskowa; Kostomłoty-II or Małe Górki) near Kostomłoty, W of Kielce, has dated the highly fossiliferous Laskowa Hill Beds as the Middle Polygnathus varcus to Klapperina disparilis Zones, with possible condensation, or even hiatuses at their bottom part. The strongly folded Szydłówek Beds, covered in the middle portion, have their base still in the early(?) K. disparilis Zone.

For the purpose of this study, the rich conodonts from the interval of the highest Szydłówek Beds (including shaly pyritic Goniatite Level) to the mainly detrital Kostomłoty Beds were re-examined (Text-fig. 4). Seven samples, containing more than 320 elements, confirmed the early Frasnian age of this lithologic contact placed at about the Pa. transitans — Pa. punctata zonal boundary (Table 4).

GÓRNO — WOLA JACHOWA

The Szydłówek Beds are traceable eastward of Kielce, and presently are best exposed in a small, active quarry on the Józefka Hill, S of Górno. The passage of secondarily dolomitized, well-bedded black deposits with crinoids and brachiopods into typically developed and at this site about 35 m thick Szydłówek Beds (complex B), is well visible in the eastern part of this outcrop.

The Górno environs were studied for conodonts by MAŁKOWSKI (1981), but the section he examined (road cut en route to Daleszyce) has been recently largely covered. The sequence described by that author apparently points to serious tectonic disturbances probably paired with lateral facies changes as being responsible for the significant thinning of the Szydłówek Beds in this escarpment, as well as for the absence of the early Frasnian detrital layers (*cf.* set B *sensu* MAŁKOWSKI 1981) in the quarry. The latter contain both light calcarenites with reef-builders and bryozoans, and dark crinoid-brachiopod micrites and shales (unit C). New scarce data confirmed the latest Givetian assignment by MAŁKOWSKI (1981) for the oldest exposed strata. The basal fossiliferous, partly biostromal Laskowa Hill Beds (set A; *cf.* RACKI & *al.* 1985) are dated in their highest portion as possibly late K. disparilis Zone while a crinoid-brachiopod intercalation within the lowest Szydłówek Beds belongs certainly to the early M. falsiovalis Zone.

In addition, a small fragment of the brachiopod-rich, higher Szydłówek Beds is poorly exposed on a hillock located SW of Wola Jachowa, 3 km E of Górno. The conodont-bearing intraformational breccia is essentially only a lithologic variation within the marly rhythmic series, and represents the basal Frasnian (?Late M. falsiovalis Zone).

CONODONTS

Almost 1800 conodont specimens, representing only *Pa* and *Pb* elements, were examined for this study. They broadly vary in state of preservation, and perfect, sometimes large-sized conodonts were found mainly in the Łysogóry facies, primarily at Kostomłoty.

The conodonts under study belong to 8 genera and at least 46 species. Representatives of almost all of the species identified (*see* Tables 1-4) are illustrated (Pls 3-9). The only exceptions are *Icriodus* aff. *brevis* STAUFFER, 1940, some species of *Ozarkodina*(?), *Polygnathus webbi* STAUFFER, 1938, and *Palmatolepis punctata* (HINDE, 1879). The main emphasis is made on early *Ancyrodella* species since they provide the main key for biostratigraphic evaluation of the strata under study. Their identification is based on the recent study by SANDBERG, ZIEGLER & BULTYNCK (1989), which provides synonymy references to earlier studies. Some basic aspects of variability range of *A. pristina* KHALYMBADZHA & CHERNYSHEVA, 1970, *A. soluta* SANDBERG, ZIEGLER & BULTYNCK, 1989, and *A. rotundiloba* (BRYANT, 1921) are shown in a diagram (Text-fig. 5); extensive quantitative study of the early ancyrodellids will only approach toward refinement of their taxonomy, especially that the types of the crucial species, *A. rotundiloba*, are stratigraphically reworked (*cf.* RACKI & WRZOŁEK 1989).

The figured specimens are deposited in the collections of the Laboratory of Paleontology and Stratigraphy of the Silesian University at Sosnowiec (Catalogue Numbers *GIUS 4–559*).

STRATIGRAPHIC INTERPRETATION

In general, the conodont faunas from the Holy Cross Mts contain many stratigraphically significant species, and despite apparent biofacies constraints, the successions can be evaluated in terms of the standard zonation as revised by SANDBERG & *al.* (1989).

RACKI (1985) documented the presence of well-developed Late Givetian K. disparilis Zone at Kostomłoty, but its upper part with *Polygnathus*(?) *dengleri* (BISCHOFF & ZIEGLER, 1957) is identified in the lower Szydłówek Beds exclusively at Szydłówek owing to rich sample *Sz-14*. The assignment of the higher part of the Laskowa Hill Beds from Górno to this latest Givetian zone (*cf.* RACKI 1985, p. 273) seems to be supported by a single specimen of the index polygnathid found in sample *Gn* A/x_2. Significantly, at a slightly higher level (sample *Gn* B_1) there occurs *Skeletognathus norrisi* (UYENO, 1967) which suggests (*cf.* FEIST & KLAPPER 1985, pp. 12-13; see also "norrisi Zone" *sensu* KLAPPER & JOHNSON *in* JOHNSON 1990) that the boundary between the Laskowa Hill Beds and the Szydłówek Beds is, in all likelihood, placed near the K. disparilis-M. falsiovalis zonal boundary on the Józefka Hill at Górno.

According to SANDBERG & *al.* (1989), the Middle/Upper Devonian boundary is to be placed within the M. falsiovalis Zone, which replaced chiefly former Lowermost P. asymmetricus Zone. The data from the both Wietrznia

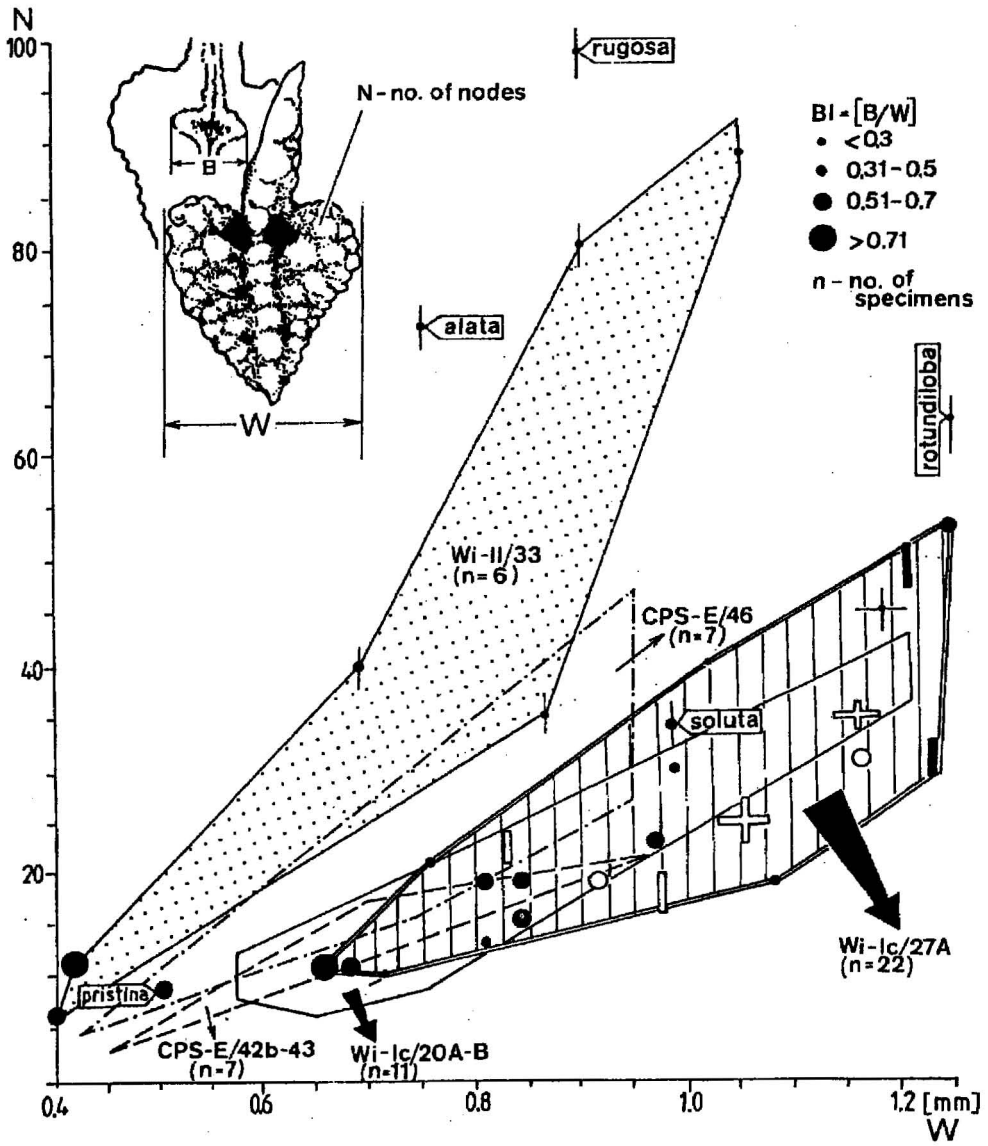


Fig. 5. Variability of early *Ancyrodella* faunas (*A. pristina, A. soluta, A. rotundiloba*) in samples from Wietrznia (*Wi*) and the global stratotype section in Montagne Noire [*CPS-E*; based largely on figures of KLAPPER (1985) with exception of 6 specimens for sample *CPS-E/46*], in comparison with the types of the three species under discussion, and the two more advanced species (*A. alata, A. rugosa*)

Variation of basal cavity/pit size (basal index; *BI*) shown for the most productive sample *Wi-Ic/27A* and for *Wi-II/33*; number of nodes, with exclusion of carina, is compared with platform width; empty signs correspond to data derived from fragmentary specimens; note the similar phylogenic position of ancyrodellids from two lower Wietrznia samples and from the oldest fauna of the global stratotype section

sections are complementary, and offer a good opportunity to analyze the conodont succession at this interval. The pre-ancyrodellid segment of this critical zone is only tentatively assumed to be present at Wietrznia-I, on the basis of frequent occurrence of *Polygnathus webbi* STAUFFER, 1940 (*cf.* KLAPPER & JOHNSON 1980, Tables 12-13; *see also* FEIST & KLAPPER 1985). This segment is well documented, however, in the basal Wietrznia Beds at Wietrznia-II where *Mesotaxis falsiovalis* SANDBERG, ZIEGLER & BULTYNCK, 1989, and *S. norrisi* are found together.

The early *Ancyrodella* phyletic succession is well expressed in the subsection *Wi-Ic* (*see* Pl. 7) althought its oldest parts, i.e. pre-soluta level, as defined by SANDBERG & *al.* (1989), is very poorly recorded, if at all, and possibly only in sample *Wi-Ic/20A* (Table 1). The three-step sequence was found: (*i*) an interval with *A. soluta* together with two more primitive species (*A. binodosa* UYENO, 1967, and *A. pristina*), (*ii*) an interval with these three species supplemented by morphotypes transitional between *A. soluta* and *A. rotundiloba* (Pl. 6, Fig. 7), and, finally, (*iii*) an interval characterized, in addition to sporadic *A. soluta*, by typical *A. rotundiloba* (?also transition toward *A. africana* GARCIA-LOPEZ, 1971; *see* Pl. 8, Fig. 6) and specimens intermediate from *A. soluta* to *A. rugosa* BRANSON & MEHL, 1934. The entry of the last species, accompanied in the area under study by stratigraphically "delayed" *A. alata* GLENISTER & KLAPPER, 1966 (*see* Text-fig. 6), is an aid for the recognition of the Pa. transitans Zone (*cf.* SANDBERG & *al.* 1989).

Other potentially useful data are provided by the icriodontid sequence (*see* Pl 3, Figs 1-8). The standard M. falsiovalis Zone is lastly correlated (*in* BULTYNCK & *al.* 1991, Fig. 3; *cf.* SANDBERG & DREESEN 1984) with two parallel *Icriodus*-based zones, *viz.* subterminus and symmetricus. The lower level, however, is almost unrecognizable in the sections studied (see sample *WI-II/6* in Table 2) where the guide *I. subterminus* YOUNGQUIST, 1947, is replaced chiefly by fairly abundant *I. latecarinatus* BULTYNCK, 1974. An early form of the next marker species *I. symmetricus* BRANSON & MEHL, 1934, accompanied by *I. expansus* BRANSON & MEHL, 1938, first appears at the A. rotundiloba level at *Wi-Ic* (see also sample *WJ-1* in Table 4). The entry of typical *I. symmetricus* is noticeably linked with the incoming of many other pelagic wide-platform Frasnian forms near the base of Pa. transitans Zone (Text-fig. 6). Another possible aid in intrazonal subdivisions in the mostly shallow-water biofacies, is the evolution of *P.*(?) *dengleri* (*see* Pl. 5, Figs 3-7), as shown by BULTYNCK & JACOBS (1981) and FEIST & KLAPPER (1985), with the most advanced variety of the former authors appearing also near this basal Frasnian level.

Although the ancyrodellid sequential pattern is developed principally at Wietrznia, the A. soluta and A. rotundiloba levels are reasonably well-established in the Czarnów section. It is significant that the formal Late M. falsiovalis Zone cannot be recognized in the Holy Cross Mts since the index species *Mesotaxis asymmetrica* (BISCHOFF & ZIEGLER, 1957) has been revealed in

course of this study as late as in the A. africana — A. pramosica level within the Pa. transitans Zone; a similar case (*see* Text-fig. 6) also holds the next standard marker *Palmatolepis transitans* MÜLLER, 1956 but not *Palmatolepis punctata.*

The well-known (KLAPPER 1985 VANDELAER & *al.* 1989) two-step ancyrodellid sequence within the Pa. transitans Zone is recognized at *Wi-II*, and its upper part ultimately at *Wi-Id*, where *A. rugosa* — *A. alata* association is quickly supplemented by *A. pramosica* PERRI & SPALETTA, 1981, and *A. africana.* The last mentioned pair is well represented in the Kostomłoty profiles, and the appearance of *A.* aff. *gigas* YOUNGQUIST, 1947 in the higher part of this level at Wietrznia-Id and Kostomłoty is in agreement with recent data of SANDBERG & *al.* (1989).

RECOGNITION OF THE MIDDLE/UPPER DEVONIAN BOUNDARY

The M. falsiovalis Zone is refined in the Wietrznia-I locality, but the exact position of the Middle/Upper Devonian boundary even in this sequence remains somewhat unclear owing more general problems. As clarified by SANDBERG & al. (1989), this is the result of an unfortunate fixation of the series boundary point in the global stratotype section (*GSSP*) in the Montagne Noire in France within the early *Ancyrodella* phylogeny, and, more importantly, its consequential misplacement within the *Mesotaxis* — *Palmatolepis* lineage that determines the standard zonation. In fact, there are no globally correlatable conodonts for this datum level, and only with reservation the two most primitive ancyrodellid species *A. binodosa* and, in particular, *A. pristina* are presumed to be useful for this purpose (*see also* Text-fig. 5).

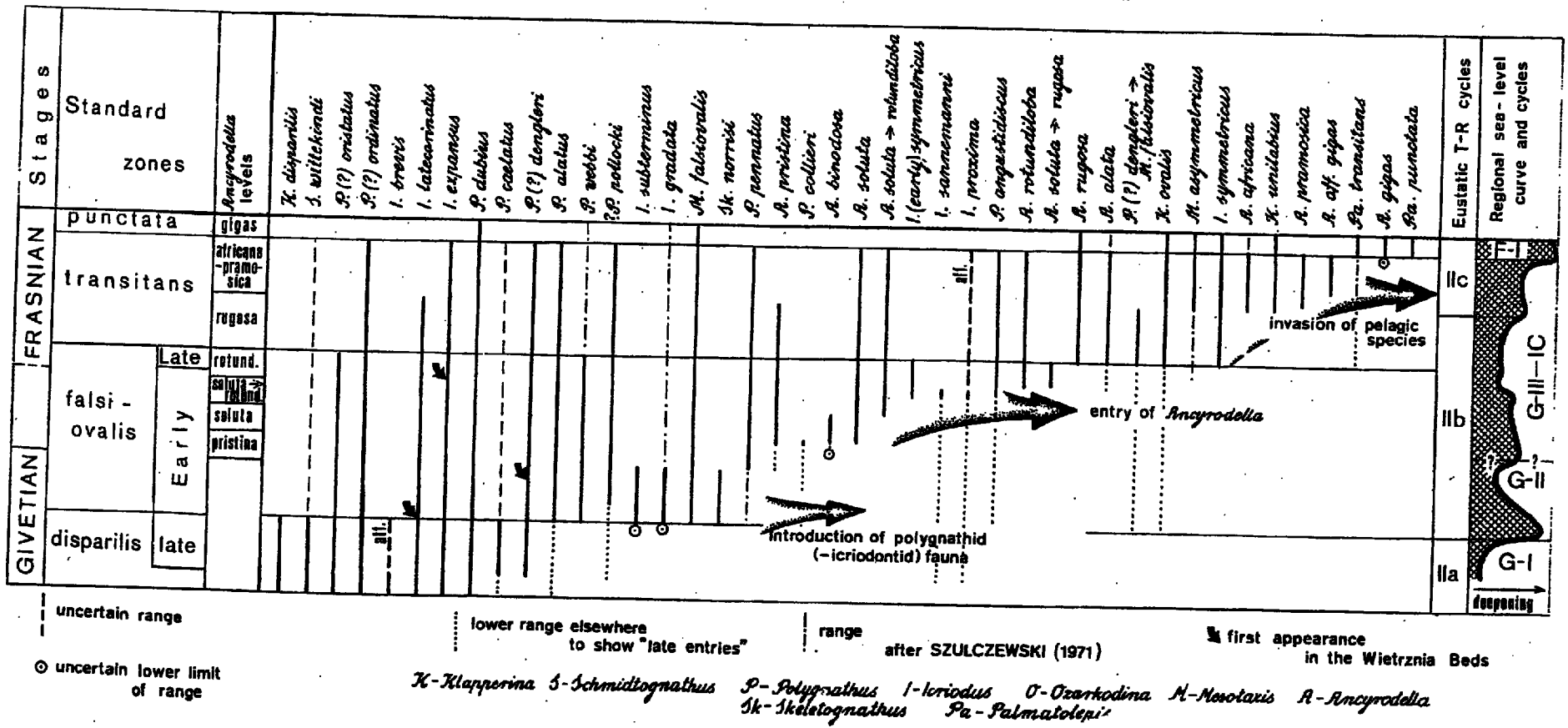
As shown above, this key event in ancyrodellid evolution is practically unrecognizable in the Holy Cross Mts, and this is a problem in common elsewhere (SANDBERG & *al.* 1989); notably, the supposed earliest species *A. binodosa*, and even its alleged ozarkodinan ancestor *O.*(?) *sannemanni*, are sparsely represented and only in association with distinctly younger faunas. The abrupt appearance of ancyrodellids in the Wietrznia and Czarnów sequences is primarily controlled by facies factors (*see below*). The base of the Upper Devonian, identified in such a way, hardly fits standards of geochronology based on evolutionary rather than ecologic events, as previously underlined by RACKI & WRZOŁEK (1989).

The correlation is uncertain also because of very low numbers of ancyrodellids recovered from the polygnathid — dominated faunas at the approved boundary level at the global stratotype; they are additionally aggravated by previously overlooked subtle hiatus of unknown magnitude in the critical bed *CPS-E* 42*a* as identified by one of us (RACKI, *in preparation*) after examining the Montagne Noire section.

In consequence, a revision of the *GSSP* is, in our opinion, urgently needed. The placement of the series boundary within the precisely documented phyletic

Conodont distribution and bio-events in the sections studied, and their proposed relationship to global eustatic T-R cycles, relative sea-level curve in the Kielce-Kostomłoty transitional area and regional cyclicity from the south-western Kielce platform (*G-I* to *F-I*; *cf.* RACKI 1988, 1993); for the P. punctata Zone only key species are shown

Icriodontid species ranges include new data from the Middle Givetian of Laskowa



event in the transition from *A. soluta* to *A. rotundiloba* remains the most reliable and globally applicable alternative (*see* BULTYNCK 1982b), and still remain in agreement with the original intent of the *Subcomission on Devonian Stratigraphy* (RACKI & WRZOŁEK 1989). For these reasons, the interval between approved and proposed conodont levels defining the Midlle/Upper Devonian boundary within the M. falsiovalis Zone, which attains up to 10 m at Wietrznia-I, is regarded herein as of uncertain series assignment.

PROBLEM OF STRATIGRAPHIC GAPS

SZULCZEWSKI (1989) assumed that synsedimentary block faulting, invoking strong condensation and hiatuses, were mainly responsible for the considerable differences of the stratigraphic record across the elevated (central) region of the Holy Cross Mts. The successions start in the Wietrznia sequence as low as the higher levels of the Lower P. asymmetricus Zone.

Our data are partly only conclusive on the subject. At least some condensation seems to be indeed present in the late M. falsiovalis Zone at Wietrznia-II (Text-fig. 3), where the overall thickness is considerable thinner than at Wietrznia-I (*see* Text-fig. 2). However, evident shortening of the *Ancyrodella* sequence near the M. falsiovalis/Pa. transitans boundary at the Czarnów section can be explained by tectonic reduction or biofacies variation.

Other causes are possibly involved in the rapid (in phylogenetic terms) entries in the sequences studied, of such index species as *A. soluta* and typical *A. rotundiloba*, jointly with forms close to *A. rugosa* and even *A. africana* at Wietrznia-I. The highly episodic (?storm-controlled) nature of the Wietrznia-type detrital deposition suggests this, and may account for the narrow gaps preceding these "biostratigraphic events". All such factors, including biofacies influence, should be considered for the refinement of chronostratigraphic inferences.

NOTES ON CONODONT BIOFACIES

General facies setting of the conodont faunas is well established (SZULCZEWSKI 1971, RACKI & *al.* 1985, RACKI 1993), and ecologic relationships in the evolving transition area from the Kielce stromatoporoid-coral platform to the Kostomłoty-Łysogóry basin, are easily discernible (Text-fig. 7). The information available, then, provides an opportune moment to test the concept of five biofacies belts advanced by SANDBERG & *al.* (1989). However, it should be underlined that distinction between strictly "pelagic" and "neritic" domains in such middle shelf settings is ambiguous as the total sea depths are much shallower than 200 m, *i.e.* invariably within the neritic realm.

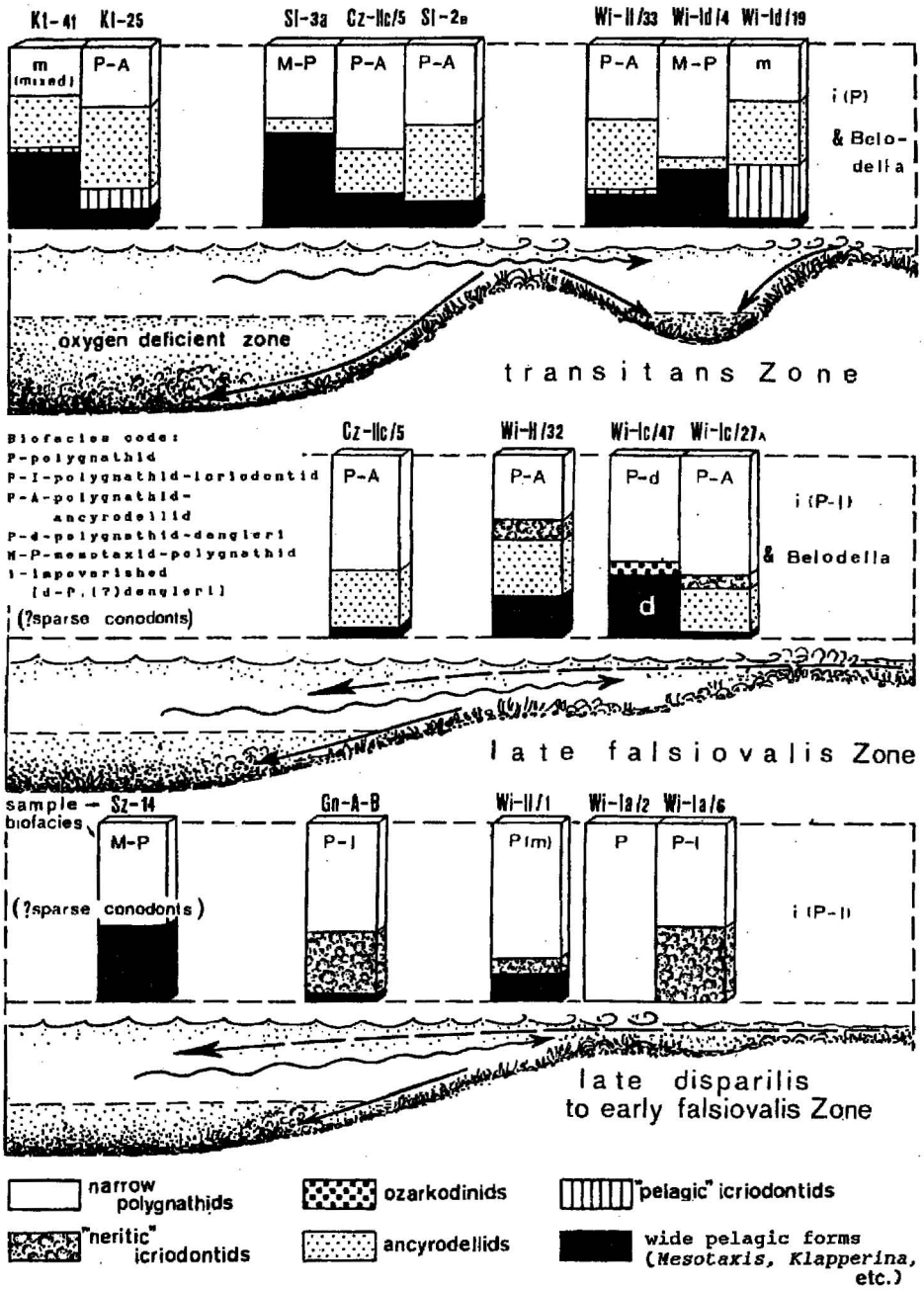


Fig. 7. Conodont biofacies distribution in representative samples (in some instances collective, e.g. *Gn A-B*; *see* Tables 1-4) for three successive time intervals across the Middle/Upper Devonian boundary; biofacies terminology and procedure follow SANDBERG & *al.* (1989)

Pre-*Ancyrodella* Late Givetian conodont associations are typified by invariably low abundances, usually below 10 elements per kg, and limited to narrow-platform polygnathids (*see* Pl. 4), in particular *P. dubius* HINDE, 1879, and *P. alatus* HUDDLE, 1934. In few exceptions, e.g. *Wi-Ia/6*, *Gn* A/x_2, they contain numerous icriodontids, mostly *I. latecarinatus*. The faunas from Wietrznia-II are also atypical as they include representatives of *Mesotaxis* and *Skeletognathus*; they are from coarse crinoidal and intraclast-bearing layers, and the conodonts might be synsedimentarily mixed. In general, in the impoverished polygnathid (*sensu* VANDELAER & *al.* 1989) to polygnathid — icriodonid biofacies aspects, the associations strongly resemble those from the more southerly part of the Kielce Region where only local faunas are unusual in taxonomic composition, e.g. enriched with *Ozarkodina brevis* (BISCHOFF & ZIEGLER, 1957) or *Polygnathus linguiformis* HINDE, 1879 (*see* RACKI 1993). All the features suggest comparison with the most shallow-water and "nearshore" biofacies belts sensu SANDBERG & *al.* (1989) but (*i*) the overall setting is considered herein to be offshore carbonate complex, and (*ii*) *Pandorinellina insita* (STAUFFER, 1940), treated commonly as the prominent indicator of the innermost, restricted regimes is absent in the Holy Cross Ms and in this part of Europe (*e.g.* BULTYNCK 1983). Thus, a severe biogeographic-ecologic control is evident in the distribution of this and other species, such as some nectobenthic(?) icriodontids within the Sitkówka bank complex (*cf.* RACKI 1993).

The invariably sparse record of conodonts suggests relative uniformity of conodont habitat across the entire Kielce Region platform, a character that is less clear if one only considers the varied lithofacies. Nevertheless, the high contribution of amphiporids and microbiotas (mostly of algal origin, like tubiform *Jansaella*; *cf.* RACKI & SOBOŃ-PODGÓRSKA 1993), allegedly inhabiting solely restricted lagoons, but present in the essentially open-marine Wietrznia Beds (SKWAREK 1989), suggests that a mixing of ecologically different conodont faunas took also place. Interestingly, this appears to hold true even in presumed deeper-water Kostomłoty basin where amphiporid branches and calcispheroid-rich arenite interbeds also commonly occur. On the other hand, only one sample from the Szydłówek Beds is assignable to pelagic polygnathid — *Klapperina* biofacies, similar to the slightly older associations from the Laskowa Hill Beds of Kostomłoty (RACKI 1985). This is probably the effect of an episodic normal marine intrusion, coupled with some starvation, within the mostly stagnant, semiclosed and oxygen-stratified intrashelf basin.

The species *Polygnathus*(?) *dengleri* displays transitional features in both morphology and ecology, between the lanceolate polygnathids and broad-platformed *Mesotaxis* (*cf.* BULTYNCK & JACOBS 1981). Present data suggest the general links with ancyrodellids but possibly a slightly different habitat within the upper carbonate slope regimes (see sample *Wi-Ic/51* in Table 1). This and other wide species of *Polygnathus*(?), and *Skeletognathus* are ultimately

included to mesotaxid ecologic group (Text-figs 3 and 7). Its first appearance together with *Ancyrodella*, so significant for biostratigraphy, may reflect the conodont response to a change to more stabilized, fully marine conditions. Such a changeover is manifested in the Wietrznia succession by intensive talus-like sedimentation on the steepening flank during the bank-to-reef transition phase. The facies transition near the Givetian/Frasnian boundary was also expressed in the development of *Ancyrodella*-bearing lime, mostly fine-grained sediments within the Kostomłoty area.

In terms of biofacies, the slightly more abundant (mainly 15-30 specimens per kg) associations of the later M. falsiovalis Zone are, in first order, assignable to polygnathid-ancyrodellid or polygnathid-*dengleri* biofacies which comprise up to 32 percent of *Ancyrodella*, and 46 percent of *P.*(?) *dengleri*. The faunas are completely devoid of *Mesotaxis*, but noticeably marked by minor contribution, less than 10 percent, of icriodontids and especially reef-dwelling *Belodella* in the Wietrznia Beds (also sample *WJ-1*; Table 4). It is indicative of effective and complex downslope transport from the accretionary reef rim (*cf.* NICOLL 1984).

A profound conodont turnover took place in the Pa. transitans Zone when a strong, earliest Frasnian deepening pulse interrupted shallow-water deposition in the Wietrznia slope area, and introduced many biogeographically new, pelagic species of *Mesotaxis* and *Klapperina*, and *Icriodus symmetricus*, as well as more advanced ancyrodellids of the *A. africana-A. pramosica* association. Diverse, marly-detrital lithologies of the *Phlogoiderhynchus* Level and coeval strata (*see* Text-fig. 2) yield a rich (above 50 elements per kg) and broadly variable conodont biofacies. Wide distributions of deeper-water polygnathid-mesotaxid, and polygnathid-icriodontid (i.e. *symmetricus*) suites are evident (*cf. also* SZULCZEWSKI 1971, Tables 3, 6-7 therein). Some samples, however, still belong to the polygnathid-ancyrodellid biofacies (*Kt-25*, *Sl-2b*, *Cz-II/5*, *Wi-II/33*) while the other can be designated as icriodontid-ancyrodellid (*Wi-Id/19*) or mixed, according to SANDBERG & *al.* (1989), ancyrodellid-mesotaxid-polygnathid (*Wi-II/32*, *Kt-41*) assemblages. It is worth to note that ancyrodellids frequently make up more than 30 percent of the element populations, i.e. significantly above the limit of 10 percent given by SANDBERG & *al.* (1989) for outer pelagic belts. This is also in contrast with typical deep-water faunas from the Pa. punctata Zone of Kostomłoty (Table 4).

All these data imply a wide extent of lateral redeposition and post-mortem sorting (*for discussion see* MCGOFF 1991) in the downslope fore-reef environments, that is sometimes evident from lithologic and/or macrofaunal analysis. An atractive alternative remains, at least to some degree, is the more complex pattern of species-level ecologic control, as discussed by MERRILL & VON BITTER (1984) for Pennsylvanian conodonts, and by KLAPPER & LANE (1985, pp. 917-920) for some Devonian genera. BULTYNCK (1983) and FEIST & KLAPPER (1985, p. 15) noted that the most primitive ancyrodellid species, *A. binodosa*,

was essentially confined to nearshore, shallow-water *Pandorinellina insita* biofacies and the further evolution of the genus corresponded to a dispersal in the more offshore domains. Similar instances are known among Devonian icriodontids (*cf.* WEDDIGE & ZIEGLER 1979, pp. 162-163), e.g. casus "euphotic" *I. symmetricus* (see SANDBERG & DREESEN 1984). An alternative is the possibility that particular *Ancyrodella* species, or even ecophenotypes have occupied quite different habitats. For example, only the robust variant of *A. rugosa* is linked with the high-energy regime at the Czarnów portion of the foreslope. On the other hand, *A. alata* was markedly delayed in its entry at the Wietrznia-type succession (*see* Text-fig. 6) and this was a probable inhabitant of more pelagic biotopes than assumed for *Ancyrodella* by SANDBERG & *al.* (1989, see distribution of *A. alata* in Table 1 therein).

REGIONAL CONSEQUENCES

The proper recognition of the Middle to Upper Devonian boundary beds allows resolution of many questions of inter-regional correlation between the Kielce and the Kostomłoty-Łysogóry facies domains. These problems are discussed by RACKI (1993), and only a few detailed points are outlined here.

The zonal assignment of the lower parts of the Wietrznia and Szydłówek Beds clearly indicates their general age equivalency, with the Givetian/Frasnian boundary placed with certainty within both these units. However, the base of the marly Szydłówek Beds is diachronous, ranging in age from the K. disparilis (Kostomłoty, Szydłówek) to the earliest M. falsiovalis (Górno) Zone. This facies expansion is an expression of the eustatic rise, initiating T-R Cycle IIb *sensu* JOHNSON & *al.* (1985), but probably complicated by differentiated morphology of the northern periphery of the Kielce platform and/or geographically changing growth potential of reef communities. A general northward progradation of the reef-rimmed shoal, following a deepening phase, is most evident in the coarsening-upward sequence at Czarnów-Śluchowice.

The Late Givetian onlap corresponds also to an incipient drowning of the southern *Stringocephalus* bank areas (*cf.* cycle *G-II* of RACKI 1988, 1993), but this is only equivocally recognized in the Wietrznia Beds, possibly because of their incomplete exposure. The lowest detrital-shaly deposits contain several species, mostly narrow-platform polygnathids and *I. subterminus*, which are highly typical of the transgressive Jaźwica Member of southern sites. Its most probable equivalent is seen in the uppermost strata at *Wi-Ia*: dark marly limestones with rhynchonellids, i.e. *Phlogoiderhynchus polonicus* and large pugnacid *Planovatirostrum*(?), and schizophoriids; these macrofaunas have also been recorded in the stratigraphically close position at Górno.

Other latest Givetian to earliest Frasnian events from the southern Kielce domain (*G/F-III* to *F-I*) are obscured northward, possibly as a result of highly

effective, more stablized carbonate ecosystem and/or local tectonic overprints (*cf.* SZULCZEWSKI 1989); the latter possibility is referred especially to coarse intraclast-rich deposits of Czarnów-Śluchowice, recording a rapid erosion episode. Nevertheless, sensitive conodont biofacies are helpful in this respect, and a quick transition from impoverished polygnathid to polygnathid — ancyrodellid associations at Wietrznia section reflects remodelling of the carbonate slope near the Givetian/Frasnian boundary, possibly joined with epeirogenic event *G/F-III*. Next, Early Frasnian submergence episode is clearly manifested in the late Pa. transitans Zone (A. africana — A. pramosica level) and this sustained inundation probably continued through the Pa. punctata Zone. This two-step onlap corresponds roughly to the transgression IIc of JOHNSON & *al.* (1985), and is more or less evident in the Kostomłoty-type successions. For example, in near-reef, detrital strata of the Czarnów-Śluchowice site there are only intervening micritic-argillaceous intercalations (*see* SZULCZEWSKI 1971, Fig. 7), but distinctive pyrite-enriched cephalopod and styliolinid horizons (RACKI & *al.* 1985, HAJŁASZ 1993) occur at Kostomłoty (*see* Text-fig. 4).

In summary, the timing of the main facies changes leads to recognition of a regional event pattern recording progressive, stepwise drowning of the Kielce platform (Text-figs 6-7; *see also* RACKI & *al.* 1985, pp. 169-170), and the Givetian/Frasnian boundary apparently coincided with a minor step in the regional geobiologic history.

FINAL REMARKS

SANDBERG & al. (1989) argued that standard conodont zonation should be based exclusively on pelagic stocks, i.e. *Mesotaxis* and its descendant *Palmatolepis*, across the Middle/Upper Devonian boundary. This interval of the Devonian Period, however, was characterized primarily by a worldwide development of banks and reefs on the extensive aggraded carbonate shelves. As exemplified by the Holy Cross succession, the employment of guide species from deeper-water environments is very limited and full of pitfalls inspite of its apparent basis of setting in varied facies. The first appearances of the major zonal indicators are almost always significantly delayed up to one whole zone (Text-fig. 6). The "late entries" reflect merely spreading bio-events (*sensu* WALLISER 1986), primarily controlled by pulsatory sea level rise encompassing eustatic cycles IIb and IIc (*see* RACKI 1993 *for discussion*).

Evidence of such migration effects of the eustatic events is common, especially well recorded in Ardennian sequences (*e.g.* BULTYNCK 1982a), but present even in the pelagic marker succession of the Montagne Noire described

by FEIST & KLAPPER (1985). Shallower-water genera, especially *Ancyrodella*, offer broad possibility for an alternative, significantly far more applicable and even more accurate, intra-zonal schemes as outlined by KLAPPER (1985) and BULTYNCK (1986; *see also* VANDELAER & *al.* 1989, KLAPPER & JOHNSON *in* JOHNSON 1990); this is particularly well demonstrable in the Wietrznia-I section. Because the exclusively „neritic" assessment of the genus *Ancyrodella* seems to be questionable, a formal zonation based on that genus is absolutely necessary as a widely useful supplement of the standard succession, and as a possible link with the shallower-water, sparse polygnathid-icriodontid faunas (*cf. also* SANDBERG & DREESEN 1984).

That there is a need for a further conodont investigation in the global stratotype section of the Middle/Upper Devonian boundary, is clearly highlighted by the present study. Nevertheless, a revision of the series boundary point, as proposed by RACKI & WRZOŁEK (1989), seems to offer the simplest resolution of this dilemma, and which is crucial for further progress in reliable correlations. Macrofaunal stratigraphic studies would provide another significant aid in the resolution of many questions of supraregional nature, especially if all the data are integrated with eustatic sea-level movements (*see* RACKI 1993).

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Department of Earth Sciences
of the Silesian University,
ul. Będzińska 60,
41-200 Sosnowiec, Poland

(G. Racki)

Institut Royal des Sciences
Naturelles de Belgique,
Rue Vautier, 29
1040 Bruxelles, Belgium

(P. Bultynck)

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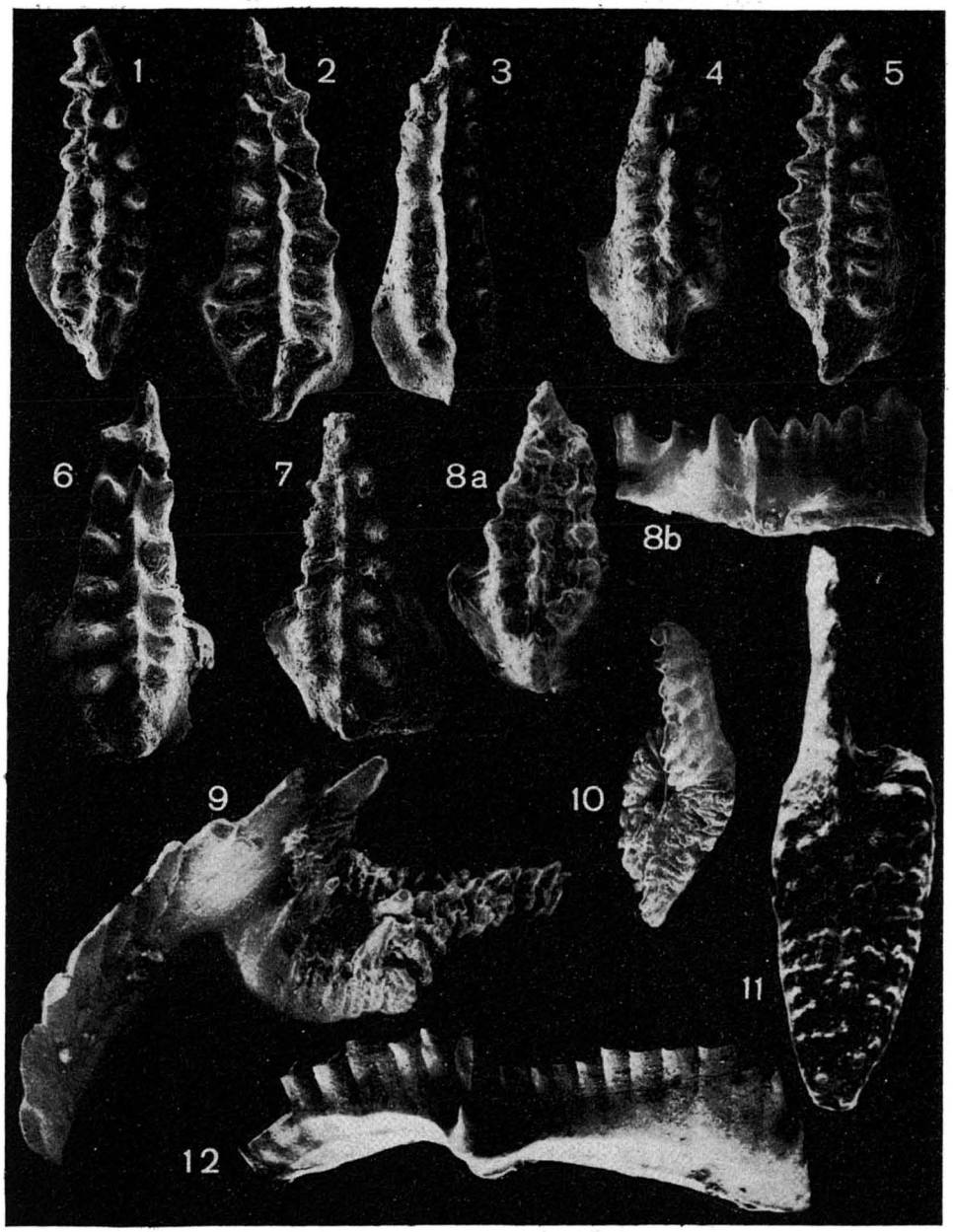
G. RACKI & P. BULTYNCK

BIOSTRATYGRAFIA KONODONTOWA POGRANICZA DEWONU ŚRODKOWEGO I GÓRNEGO W OKOLICACH KIELC

(Streszczenie)

Badania konodontów z kostomłockiego obszaru facjalnego, przejściowego między regionem kieleckim a łysogórskim, pozwoliły na biostratygraficzne udokumentowanie słabo dotąd poznanego fragmentu dewońskiej sekwencji węglanowej, obejmującej zony od późnej disparilis do transitans (*patrz* fig. 1-6, tabele 1-4 oraz pl. 1-9). Kluczowa dla rozpoznania granicy dewonu środkowego i górnego sukcesja wczesnych gatunków *Ancyrodella* w profilach Wietrzni i Czarnowa, a także filetyczna sukcesja tych gatunków w profilu Wietrznia-I, umożliwiła podział zony falsiovalis na 4 poziomy ancyrodellidowe. Niemniej jednak, główne etapy w rozwoju badanej fauny konodontowej, łącznie z pierwszym wystąpieniem ancyrodell, były w sposób oczywisty uwarunkowane zmianami facjalnymi związanymi ze skokowym zatapianiem płycizny kieleckiej. Gwałtowne przejścia od zubożałej biofacji polygnatidowej przez polygnatidowo-ancyrodelidową (lub *dengleri*) do bogatej asocjacji pelagicznej z mesotaksidami i ikriodontidami odzwierciedla ów ciągle narastający trend eustatyczny. Generalny brak najbardziej wczesnych faz ewolucyjnych ancyrodell w faunie świętokrzyskiej wynika z tych właśnie przyczyn i ma konsekwencje w niejasnej korelacji z punktem granicznym w stratotypie światowym. W pracy uwypuklone zostały problemy rewizji pozycji tego reperu chronostratygraficznego oraz przypuszczalnie złożonych relacji ekologicznych wśród ancyrodell, a także potrzeba ilościowej analizy zmienności wczesnych gatunków rodzaju *Ancyrodella*.



Icriodontids and non-platform polygnathids

1-3 — *Icriodus symmetricus* BRANSON & MEHL, 1934: upper views; Wi-Ic/27C (1 — early morphotype), Wi-Id/1 (2), Kt-25 (3); × 33 (1, 3), × 53 (2)

4-5 — *Icriodus expansus* BRANSON & MEHL, 1938: upper views; Wi-II/33 (4; × 53), Wi-Ic/27C (5; × 33)

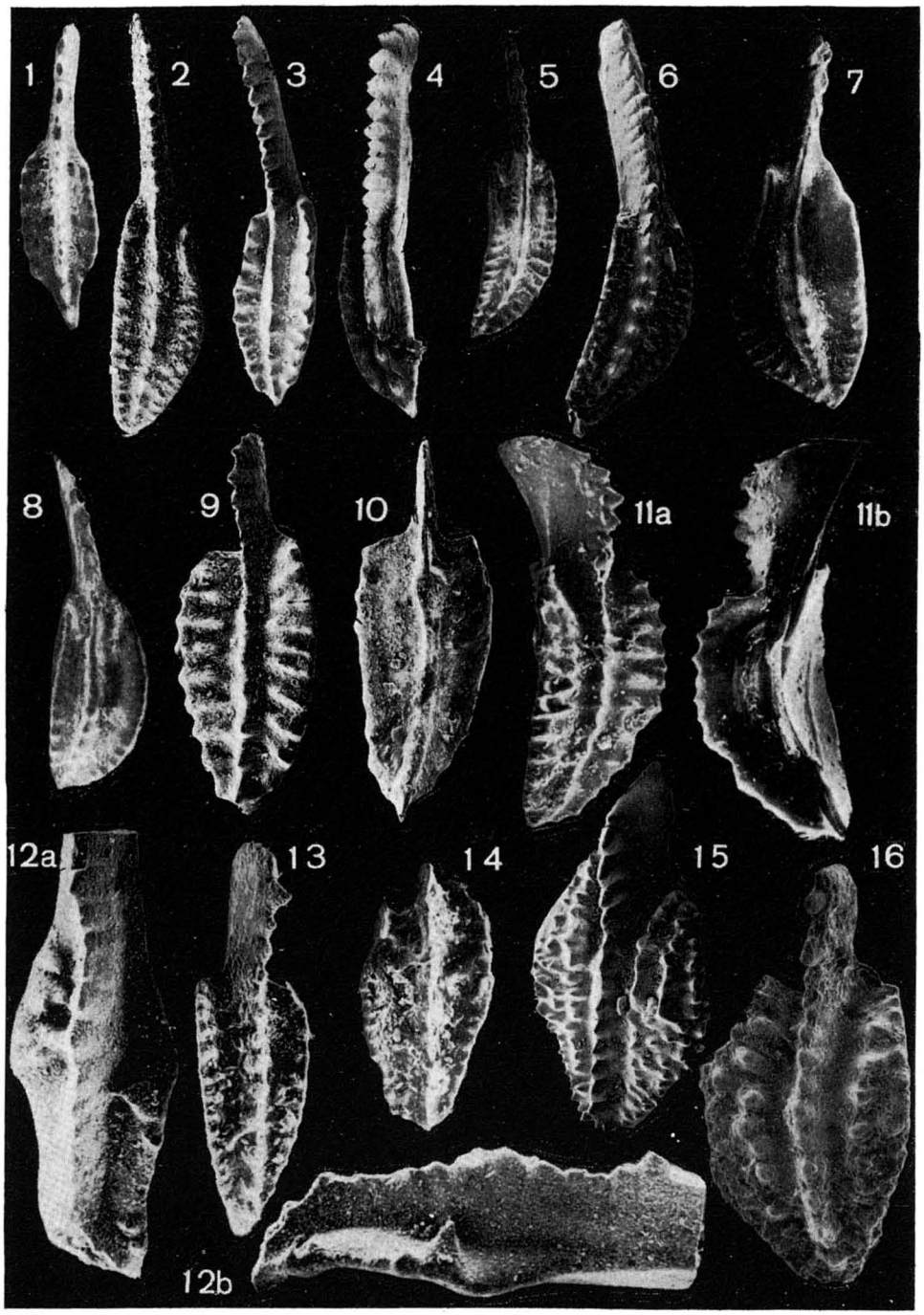
6-7 — *Icriodus latecarinatus* BULTYNCK, 1974: upper views; Wi-Ia/5 (6; × 52), Wi-II/26 (7; × 33)

8 — *Icriodus subterminus* YOUNGQUIST, 1947: specimen in upper (a) and lateral (b) views; Wi-II/6; × 75

9-10 — *Skeletognathus norrisi* (UYENO, 1967): *Pb* element in oblique-lateral (9) and *Pa* element in upper (10) views; Wi-II/6 (9; × 100), Wi-II/1 (10; × 50)

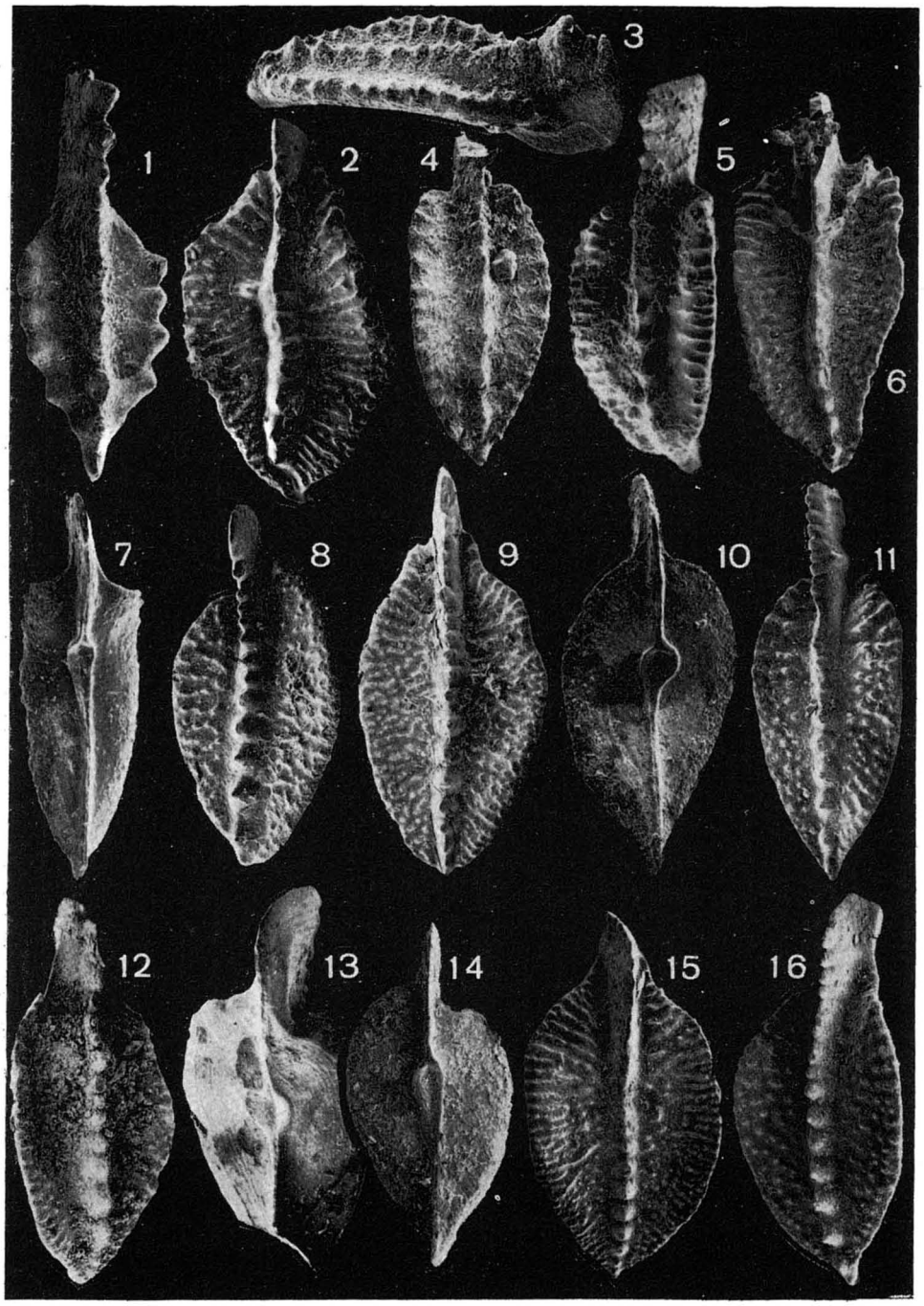
11 — *Schmidtognathus peracutus* ZIEGLER, 1965: upper view; Sz-14; × 50

12 — *Ozarkodina*(?) aff. *proxima* (POLLOCK, 1968): lateral view; Kt-25; × 35

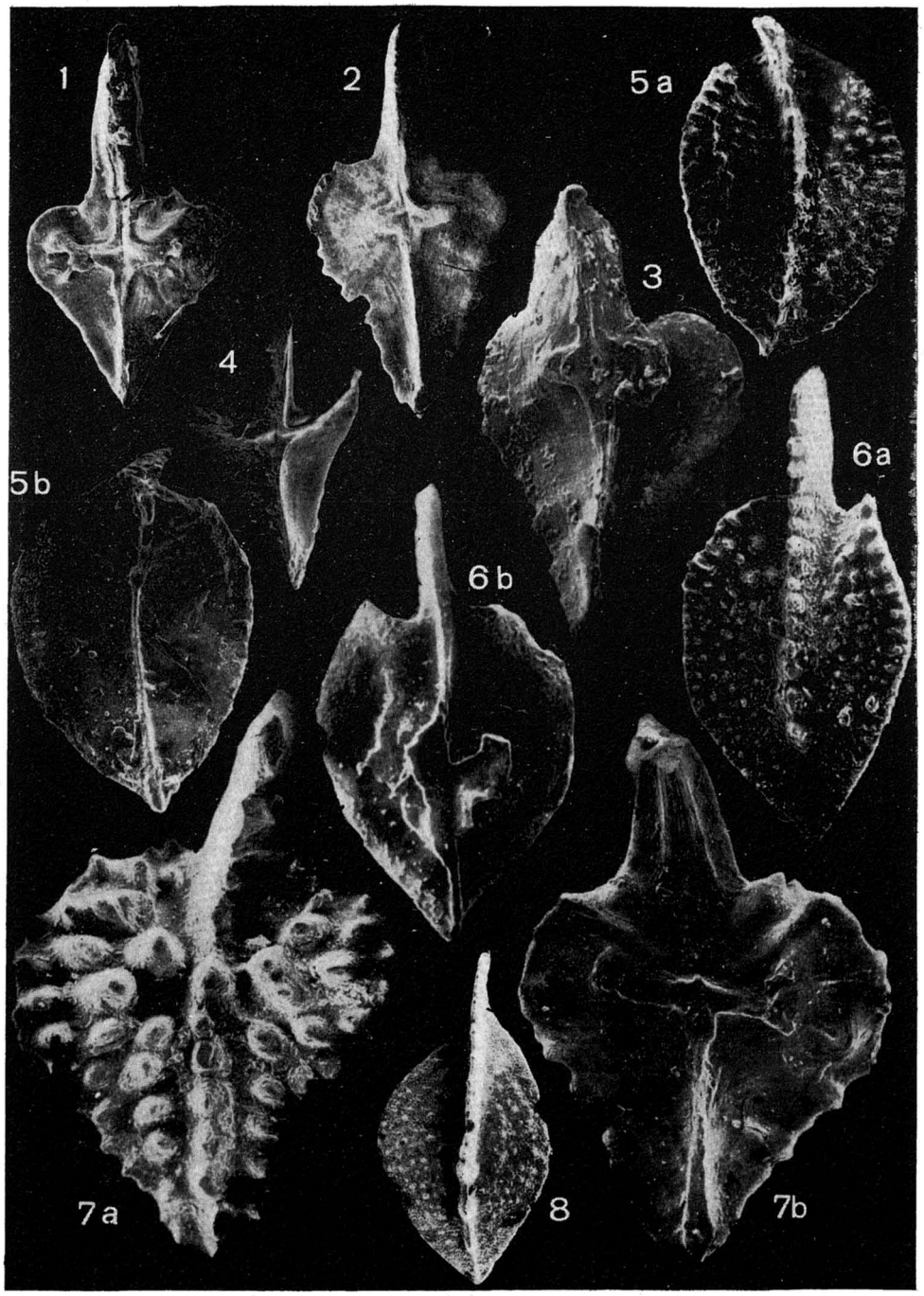


1 — *Polygnathus angustidiscus* YOUNGQUIST, 1947: upper view; Wi-Id/42
2 — *Polygnathus dubius* HINDE, 1879: upper view; Wi-Ic/PB-1
3-5 — ?*Polygnathus pollocki* DRUCE, 1976: upper views; Cz/PB-7 (3-4), Kt-41 (5)
6 — *Polygnathus aequalis* KLAPPER & LANE, 1985: upper view; Kt-61
7-8 — *Polygnathus alatus* HUDDLE, 1934: upper views of specimens with tendency to *P. webbi* STAUFFER, 1938; Wi-Ib/13 (7), WJ-1 (8)
9-11 — *Polygnathus pennatus* HINDE, 1879: upper (9, 11a) and lower (10, 11b) views; Wi-Ic/65 (9-10), Cz-IIc/5 (11)
12 — *Polygnathus caelatus* BRYANT, 1921: upper (a) and lateral (b) views of damaged specimen; Sz-14
13-14 — *Polygnathus*(?) *dengleri* (BISCHOFF & ZIEGLER, 1957): upper views; Sz-14 (13), Gn-A/x_2 (14; free blade broken)
15 — *Polygnathus*(?) *cristatus* HINDE, 1879: upper view; Wi-Ic/65
16 — *Polygnathus*(?) *ordinatus* BRYANI, 1921: upper view; Cz-IIc/5

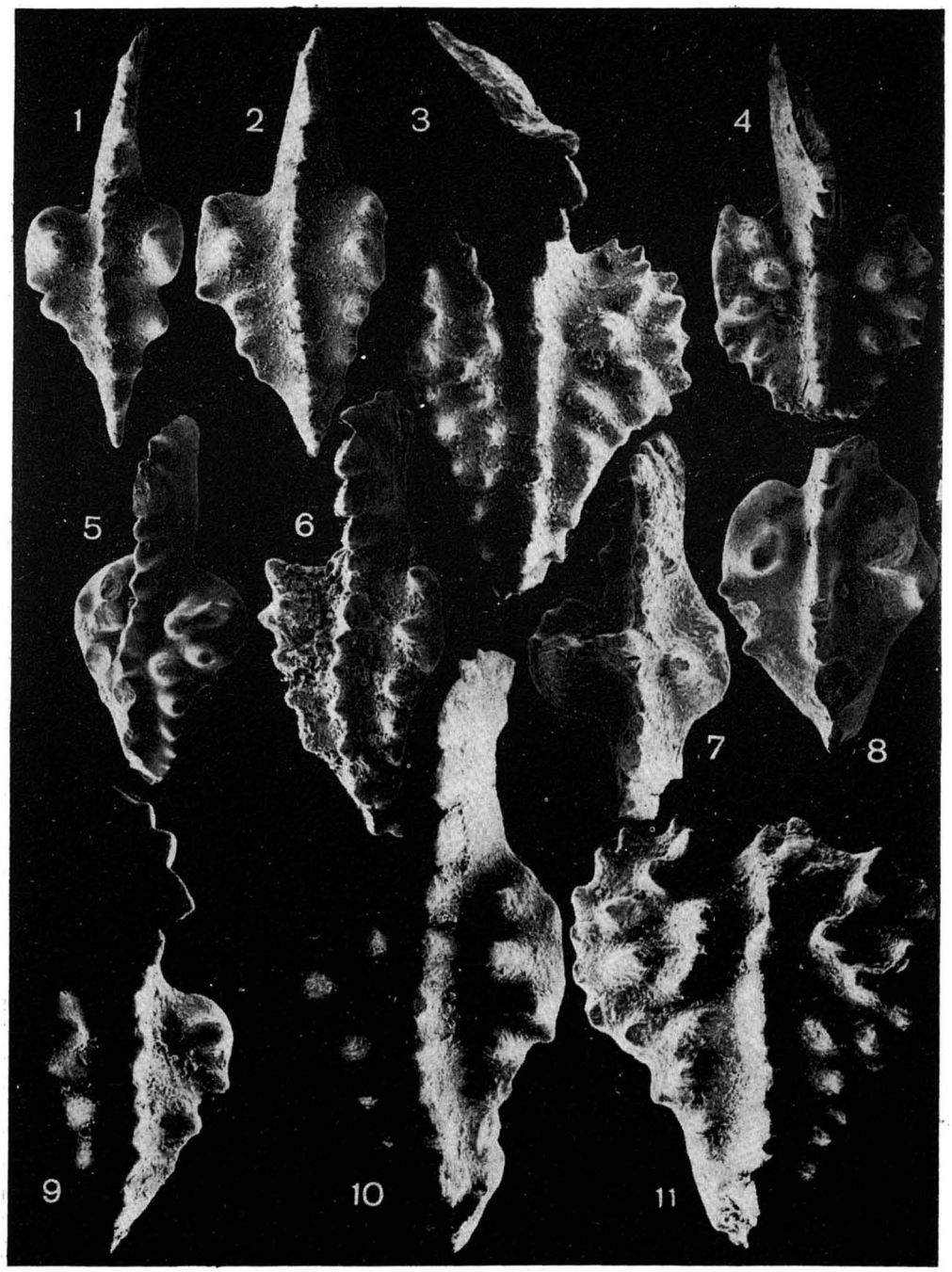
All × 50 except for 5-6, 9-10 (× 32), and 15 (× 28)



1 — *Polygnathus collieri* BRYANT, 1921: upper view; Wi-Ic/20A; × 30
2 — *Polygnathus* cf. *caelatus* BRYANT, 1921: upper view; Cz-IIc/5; × 40
3-7 — *Polygnathus*(?) *dengleri* (BISCHOFF & ZIEGLER, 1957): lateral (3), lower (4-6) and upper (7) views; Wi-Ic/47 (3, 7), Wi-Ic/20A (4), Cz-IIc/5 (5-6); × 46 (3, 7), × 33 (4), × 50 (5)
8, 10-11 — *Klapperina ovalis* (ZIEGLER & KLAPPER, 1964): upper (8, 11) and lower (10) views; Cz/PB-7 (8), Wi-II/33 (10-11); × 33 (8, 10), × 46 (11)
39 — *Polygnathus*(?) *dengleri* (BISCHOFF & ZIEGLER, 1957) → Mesotaxis falsiovalis SANDBERG, ZIEGLER & BULTYNCK, 1989: upper view; Cz-IIc/5; × 40
12-13 — *Klapperina unilabius* (HUDDLE, 1981): upper (12) and lower (13) views; Kt-II/25; × 33 (12), × 47 (13)
14-16 — *Klapperina ovalis* (ZIEGLER & KLAPPER, 1964): lower (14) and upper (15-16) views; Cz/PB-7 (14), Wi-II/33 (15-16); × 33 (14-15), × 50 (16)

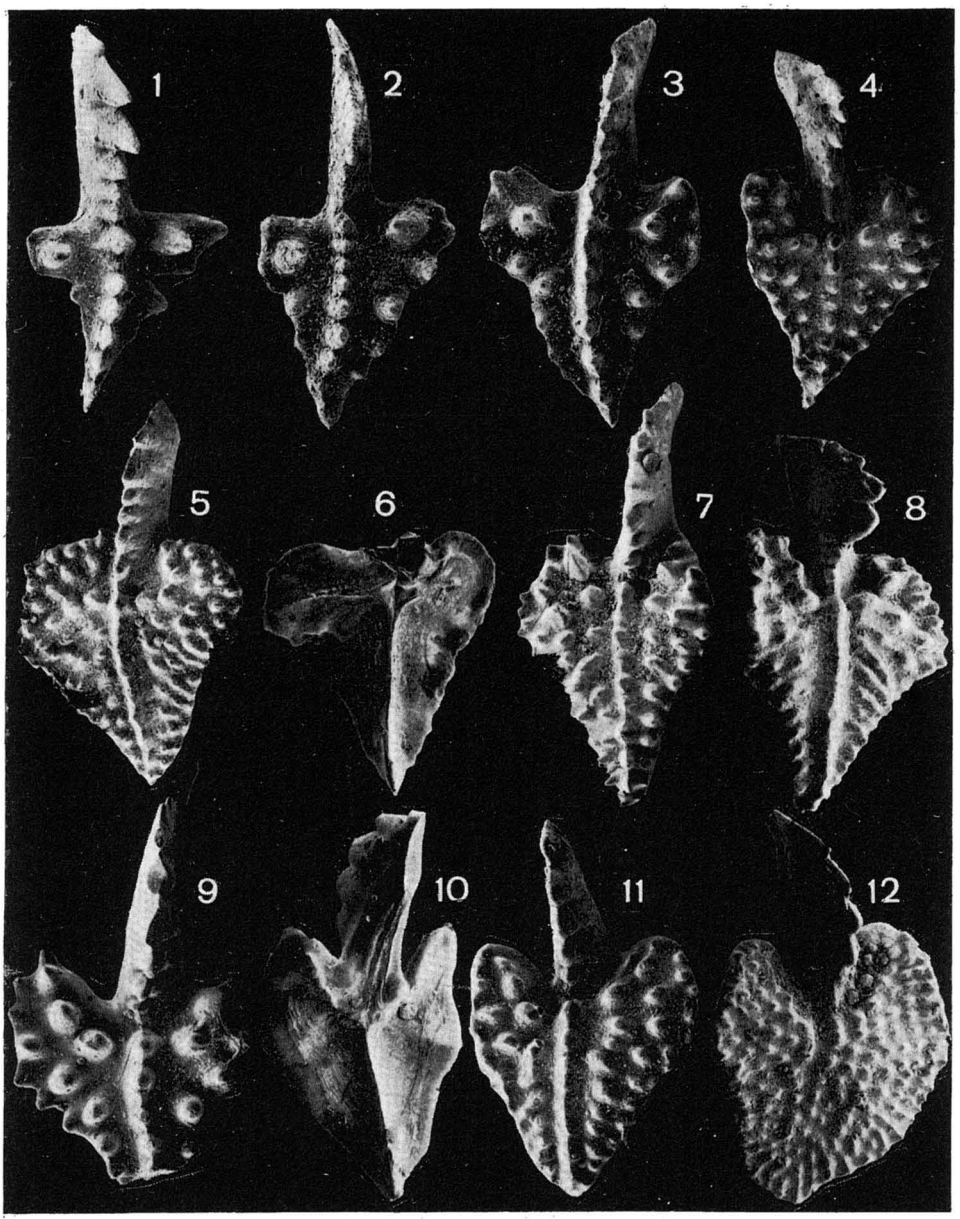


1 — *Ancyrodella pristina* KHALYMBADZHA & CHERNYSHEVA, 1970: lower view (*see* Pl. 7, Fig. 5 for upper view); Wi-II/22
2-3 — *Ancyrodella soluta* SANDBERG, ZIEGLER & BULTYNCK, 1989: lower views; Wi-Ic/PB-1 (2) and Cz-IIc/1 (3 — blade incomplete)
4 — *Ancyrodella gigas* YOUNGQUIST, 1947: lower view of juvenile specimen; Kt-52
5 — *Mesotaxis falsiovalis* SANDBERG, ZIEGLER & BULTYNCK, 1989: upper (a) and lower (b) views of element without free blade; Wi-II/1
6 — *Klapperina disparilis* (ZIEGLER & KLAPPER, 1976): upper (a) and lower (b) views; Sz-14
7 — *Ancyrodella soluta* SANDBERG, ZIEGLER & BULTYNCK, 1989 → A. rotundiloba (BRYANT, 1921): upper (a) and lower (b) views; Wi-Ic/27A
8 — *Mesotaxis asymmetrica* (BISCHOFF & ZIEGLER, 1957): juvenile specimen in upper view; Kt-25
All × 50 except for 1 (× 30) and 2 (× 27)



Earliest *Ancyrodella* species from Wietrznia

1-3, 9-11 — *Ancyrodella soluta* SANDBERG, ZIEGLER & BULTYNCK, 1989: upper views of two ontogenetic series; Wi-Ic/PB-1 (1-3; 3 — blade mostly broken) and Wi-Ic/27C (9-11; 11 — platform only); × 50
4 — *Ancyrodella rotundiloba* (BRYANT, 1921): upper view of incomplete specimen; Wi-Ic/60 (× 33)
5-6 — *Ancyrodella pristina* KHALYMBADZHA & CHERNYSHEVA 1970: upper views; Wi-II/22 (5; × 30) and Wi-Ic/27A (6; × 42)
7-8 — *Ancyrodella binodosa* UYENO, 1967: upper views of elements with incomplete blade; Wi-II/22 (7; × 46) and Wi-Ic/47 (8; × 30)

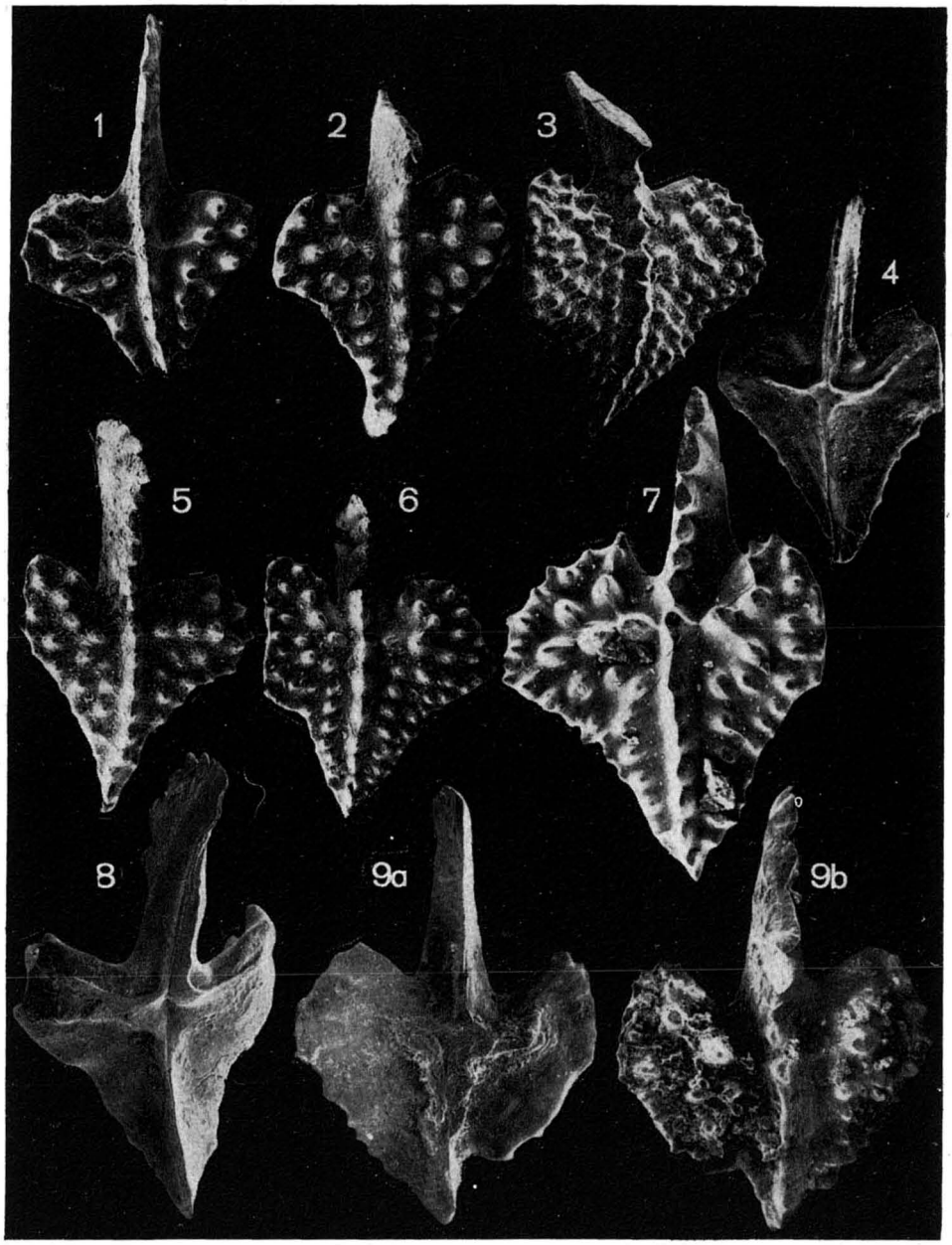


Ancyrodella species

1-5, 7-8 — *Ancyrodella rotundiloba* (BRYANT, 1921): upper views; Wi-II/33 (1-5; ontogenic series), Kt-25 (7) and Wi-Ic/60 (8); × 66 (1), × 62 (2), × 58 (3), × 40 (4), × 32 (5), × 30 (7) and × 28 (8)

6 — ?*Ancyrodella rotundiloba* (BRYANT, 1921) → Ancyrodella africana GARCIA-LOPEZ, 1981: lower view of platform; Wi-Ic/65; × 32

9-12 — *Ancyrodella rugosa* BRANSON & MEHL, 1934: upper (9, 11-12) and lower (10) views; 12 — specimen identical to the holotype of *A. sinecarina* SZULCZEWSKI, 1971 (Pl.1, Fig. 6); Cz-IIc/5 (9; anterior tip broken), Cz-IIc/10 (10, 12) and Wi-II/33 (11); × 46 (9), × 33 (10-11) and × 30 (12)



Ancyrodella species

1-4 — *Ancyrodella alata* GLENISTER & KLAPPER, 1966: upper (1-3) and lower (4) views; 3 — specimen with incomplete free blade, similar in outline to the paratype *UWA* 35807 of the species *in* GLENISTER & KLAPPER (1966, Pl. 86, Figs 1-2); Wi-Id/1 (1), Wi-II/33 (2,4) and Wi-Ie/12 (3); × 33 (1), × 42 (2), × 40 (3-4)

5 — *Ancyrodella pramosica* PERRI & SPALETTA, 1981: upper view; Wi-II/33; × 50

6-8 — *Ancyrodella africana* GARCIA-LOPEZ, 1981: upper (6-7) and lower (8) views; Wi-II/33 (6; × 35) and Cz-IIc/5 (7-8; × 50)

9 — *Ancyrodella* aff. *gigas* YOUNGQUIST 1947: upper (a) and lower (b) views; Kt-41; × 50